MECHANICAL ENGINEERING

· DECEMBER 1948 ·

The Education of Professional Students for Citizenship . . . *E. D. Smith* 959

Engineering in an Era of Big Science and Big Business . . . *Wilson Compton* 963

Developments in Burning Pulverized Coal . . . *F. L. Dornbrook* 967

The Status of High-Speed Digital Computing Systems . . . *H. D. Huskey* 975

Engineering Research . . . *L. M. K. Boelter* 978

Tools and Techniques of Management . . . *R. W. Elsasser* 979

Styling and the Mechanical Designer . . . *E. D. Hay* 983

Use of a Technical Library . . . *R. H. Whitford and J. B. O'Farrell* 987

ECPD Annual Meeting . . . 994

The New Look in Economics . . . *E. C. Brown* 996

Departments

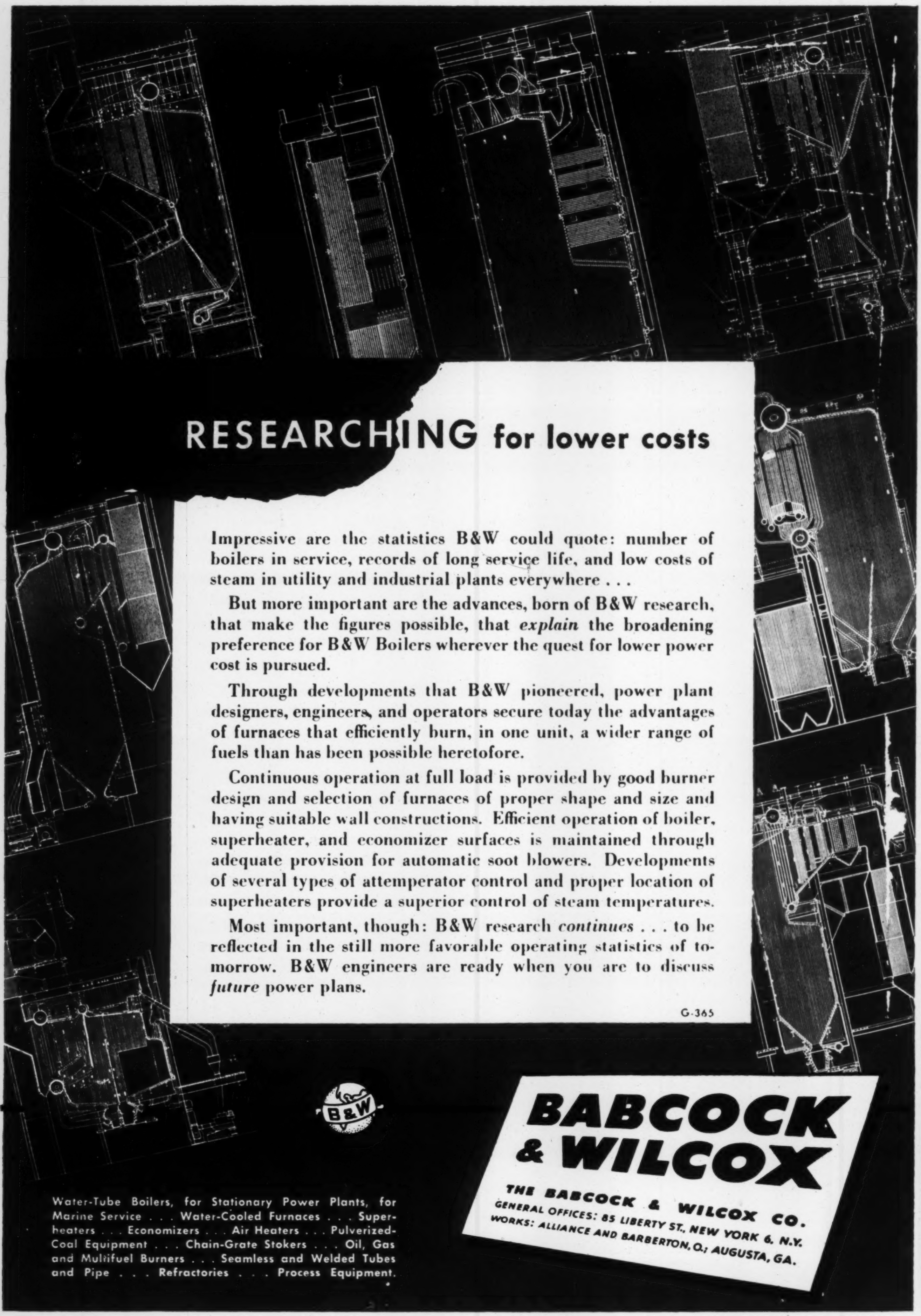
Briefing the Record, 998

ASME Technical Digest, 1012

The Engineering Profession—News and Notes, 1030

ASME News, 1036

Keep Informed, *Adv. Pg.* 41



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Impressive are the statistics B&W could quote: number of boilers in service, records of long service life, and low costs of steam in utility and industrial plants everywhere . . .

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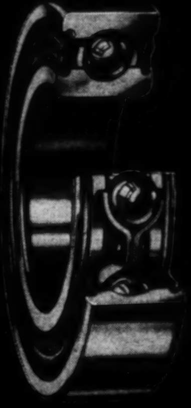

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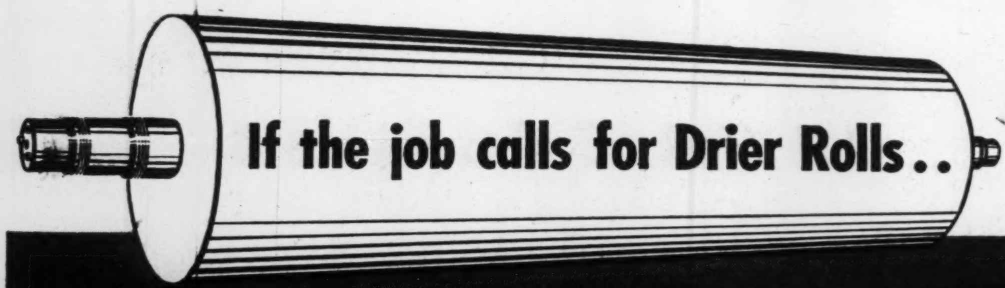
For Editorial Contents See page 955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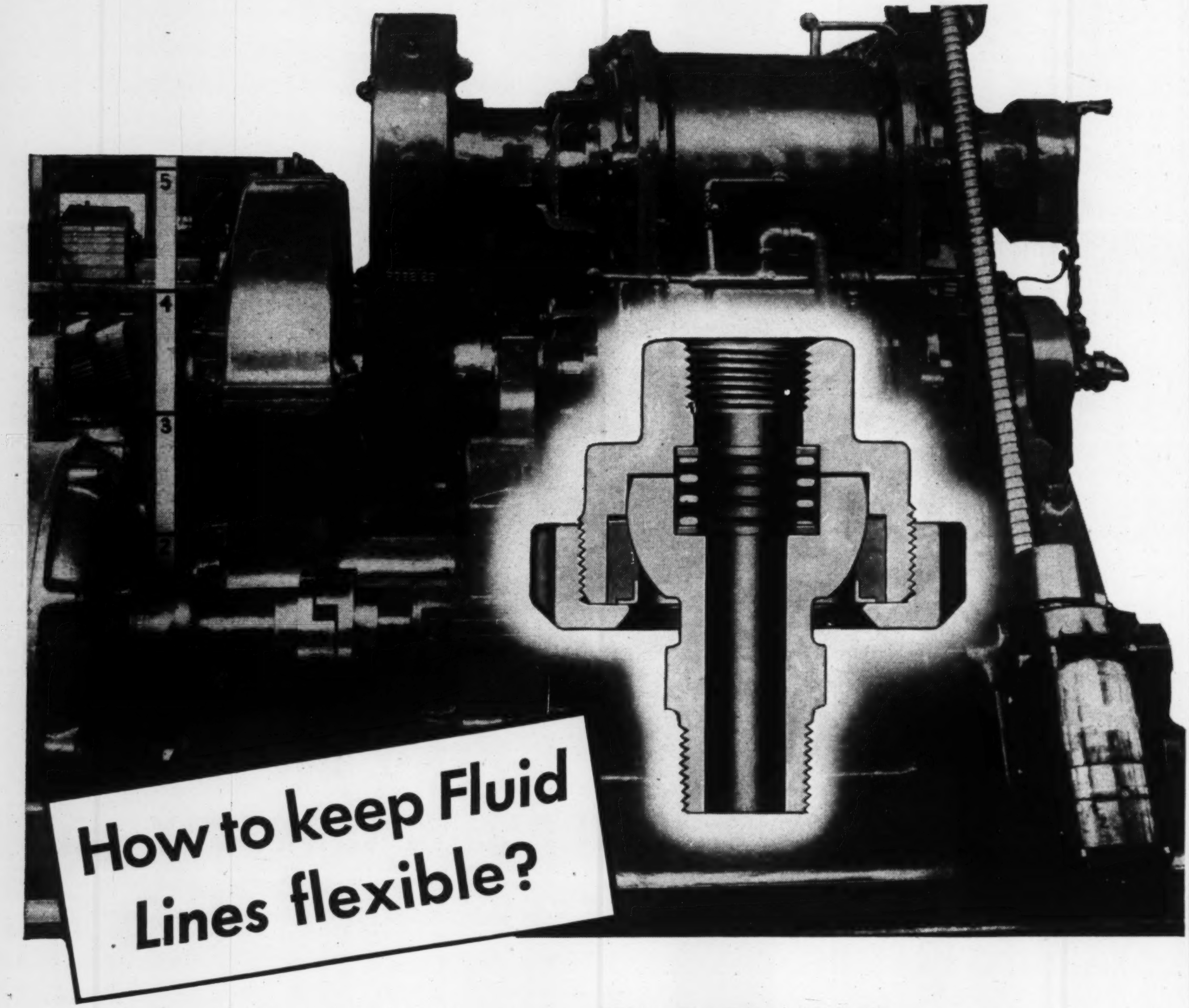

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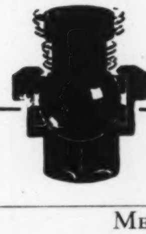

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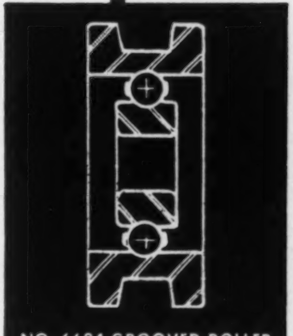

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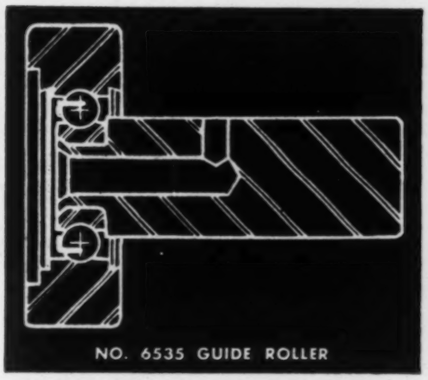

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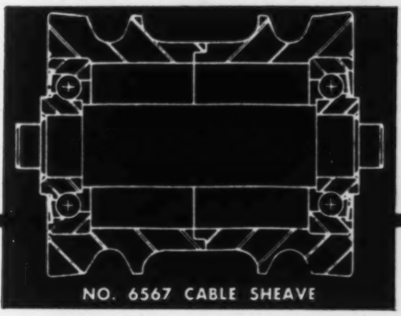

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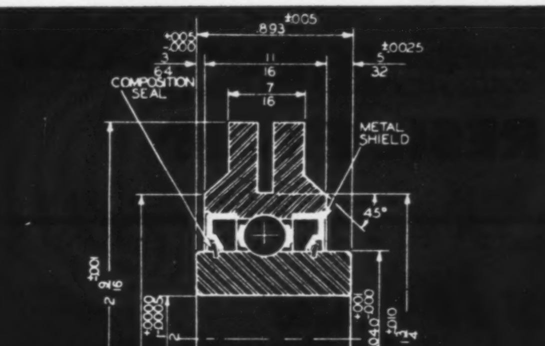
±.005
.893
+.005
-.000
3/64
11/16
±.0025
5/32
COMPOSITION SEAL
7/16
METAL SHIELD
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1/2 +.0000 -.0005
1.040 +.001 -.000
1 3/4 ±.010
1 3/4 ±.010
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1/2

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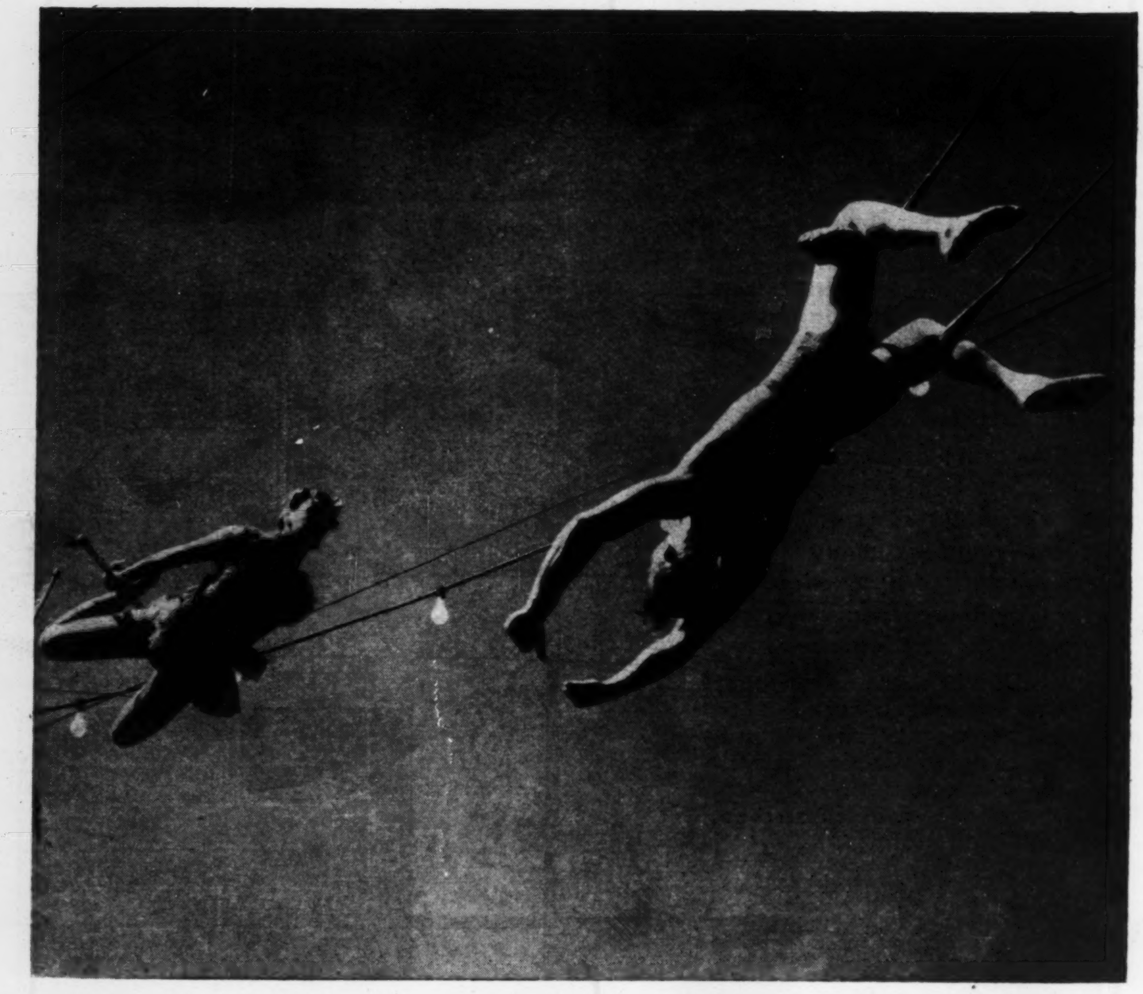

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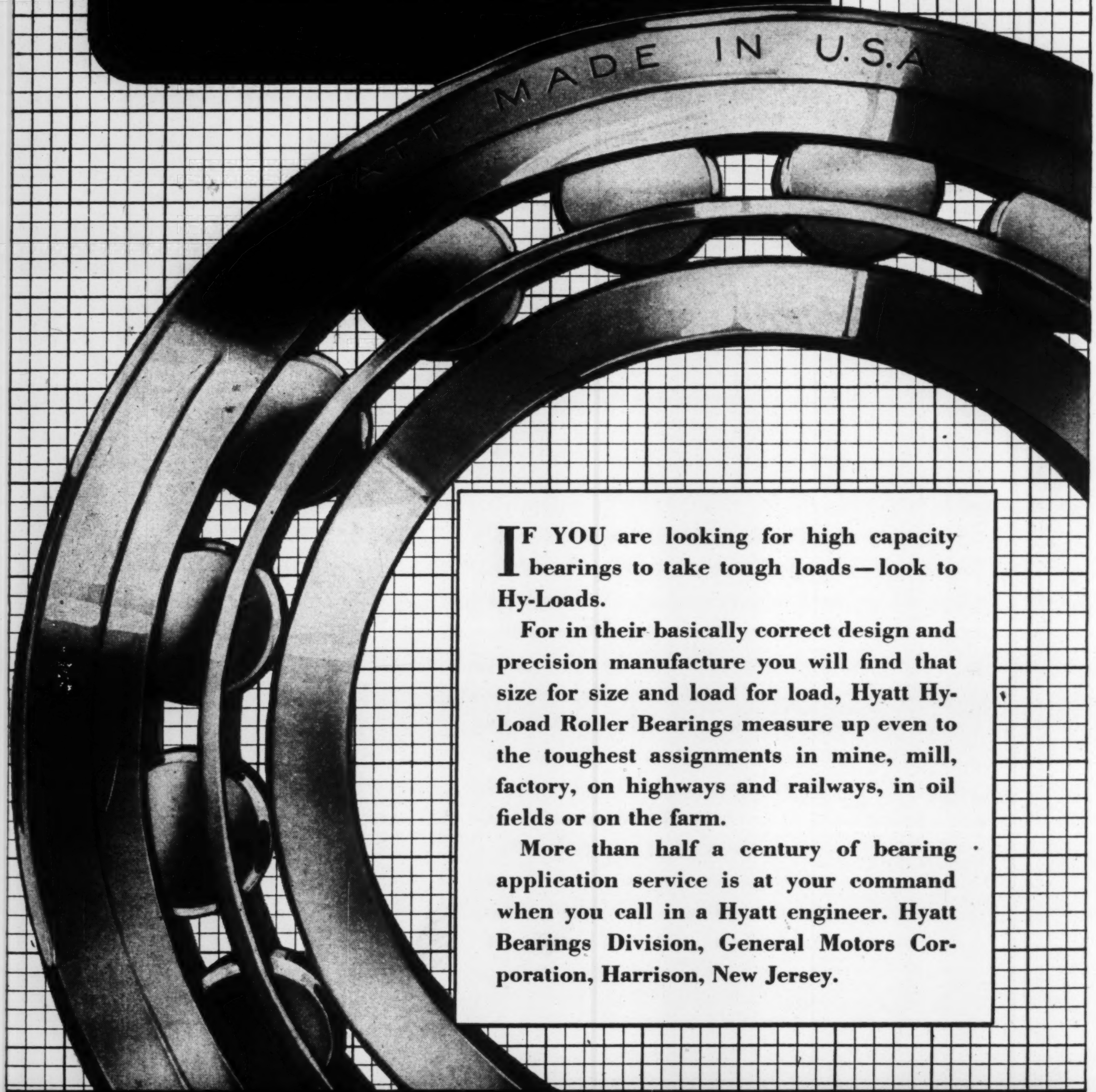

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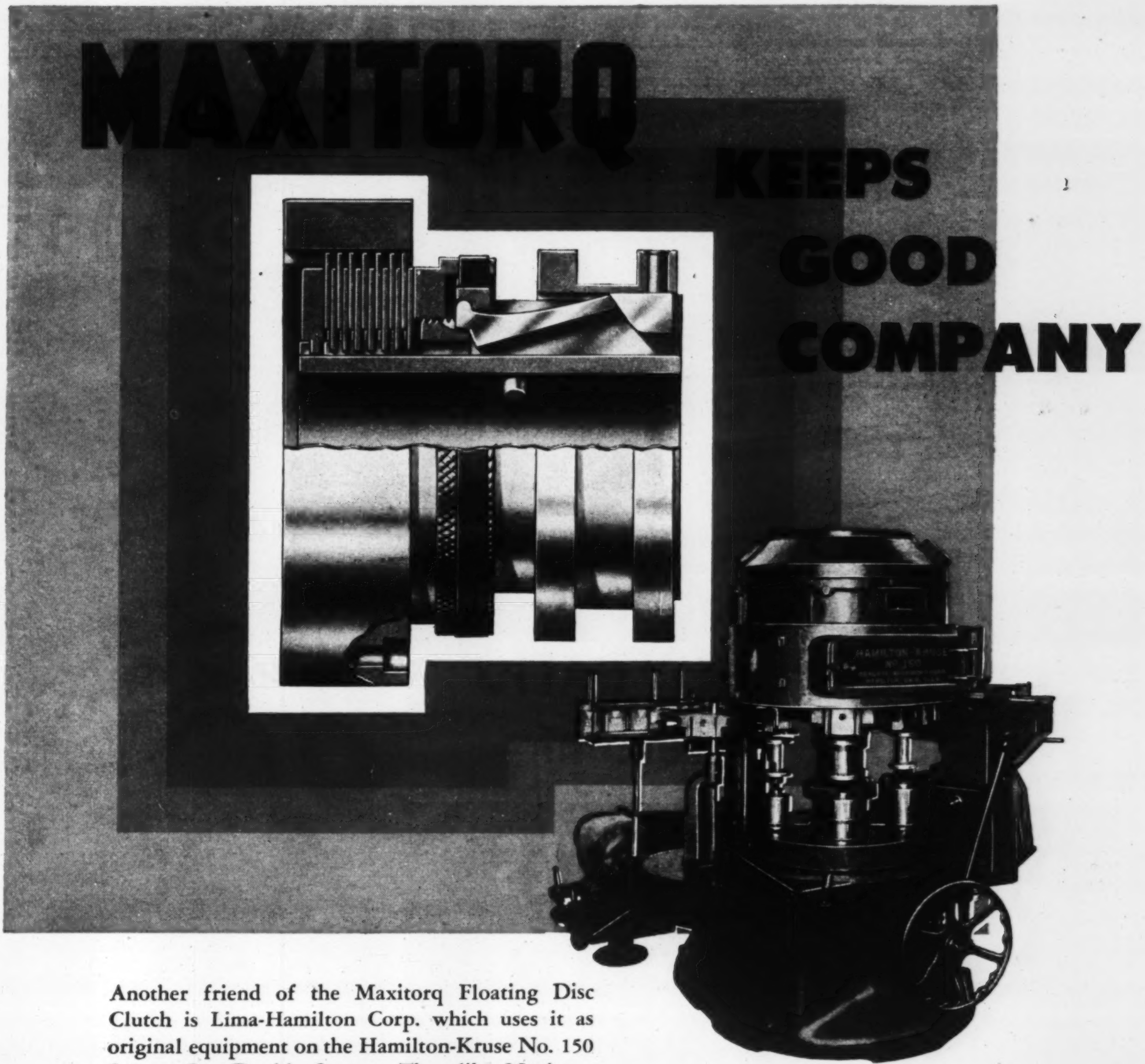

Another friend of the Maxitorq Floating Disc Clutch is Lima-Hamilton Corp. which uses it as original equipment on the Hamilton-Kruse No. 150 Square Can Double Seamer. They like Maxitorq "because the Separator Springs between discs prevent drag . . . and the cushioning effect in starting is a valuable clutch feature."

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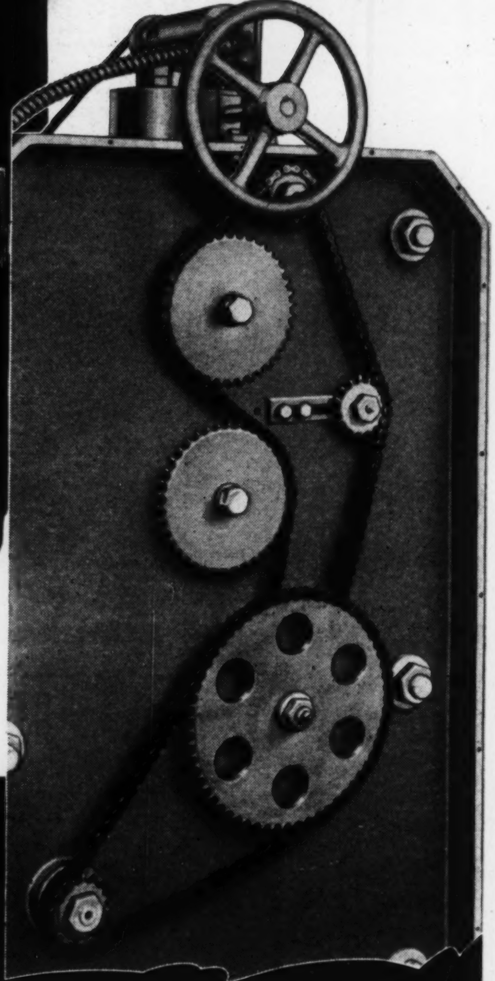
Close-up of Diamond Chain Drives on Union Coating Machine (Union Tool Corp., Warsaw, Indiana).



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3. Slow motion eliminates hydraulic shock
4. Compact, built-in Rate Controllers for wash or rinse
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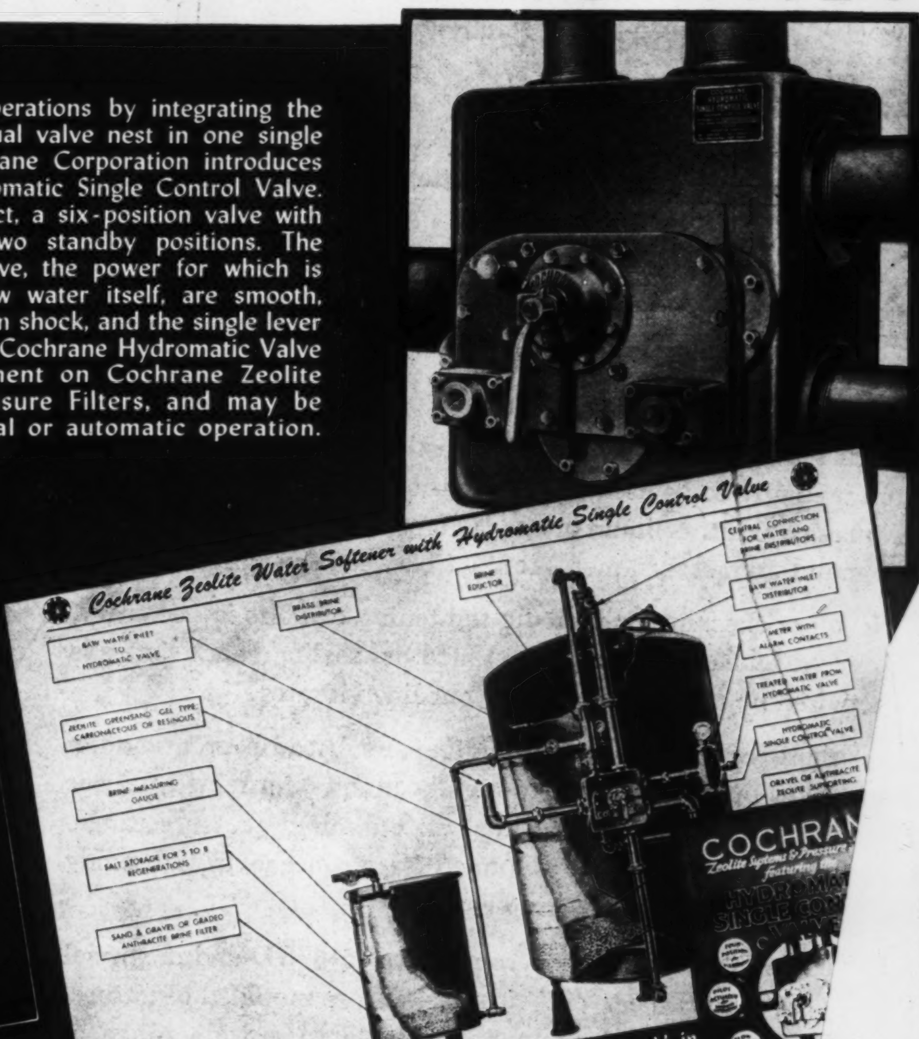
Cochrane Zeolite Water Softener with Hydromatic Single Control Valve
RAW WATER INLET TO HYDROMATIC VALVE
BRASS BRINE DISTRIBUTOR
BRINE EDUCTOR
CENTRAL CONNECTION FOR WATER AND BRINE DISTRIBUTORS
RAW WATER INLET DISTRIBUTOR
METER WITH ALARM CONTACTS
TREATED WATER FROM HYDROMATIC VALVE
HYDROMATIC SINGLE CONTROL VALVE
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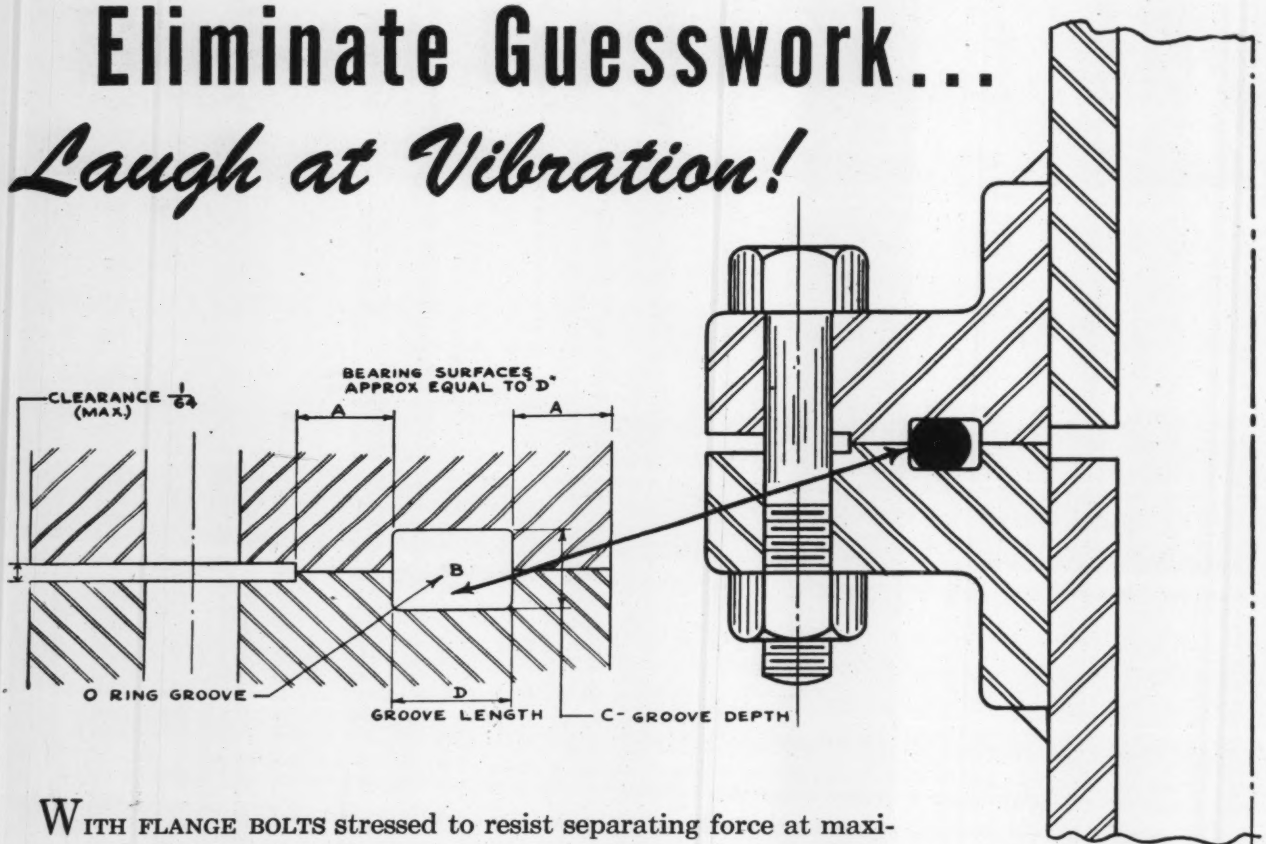

"O" ring gasket for flange fittings. Groove detail shows use of the gasket.

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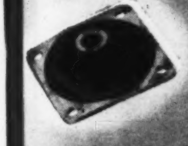


MULTIPLANE MOUNTINGS—

isolate vibration from all directions. Light in weight, small in size, they are widely used to mount electronic units.

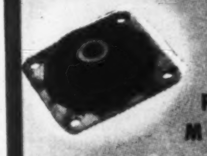
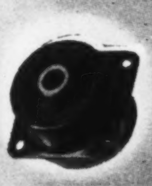


PLATE FORM MOUNTINGS—

Standard—isolate steady vibration. Stable, compact—easily installed. Loads ½ to 120 pounds per mount.



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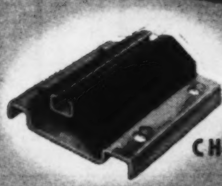

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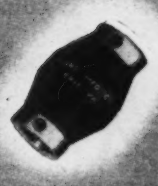

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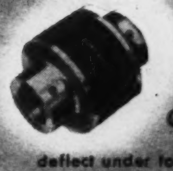

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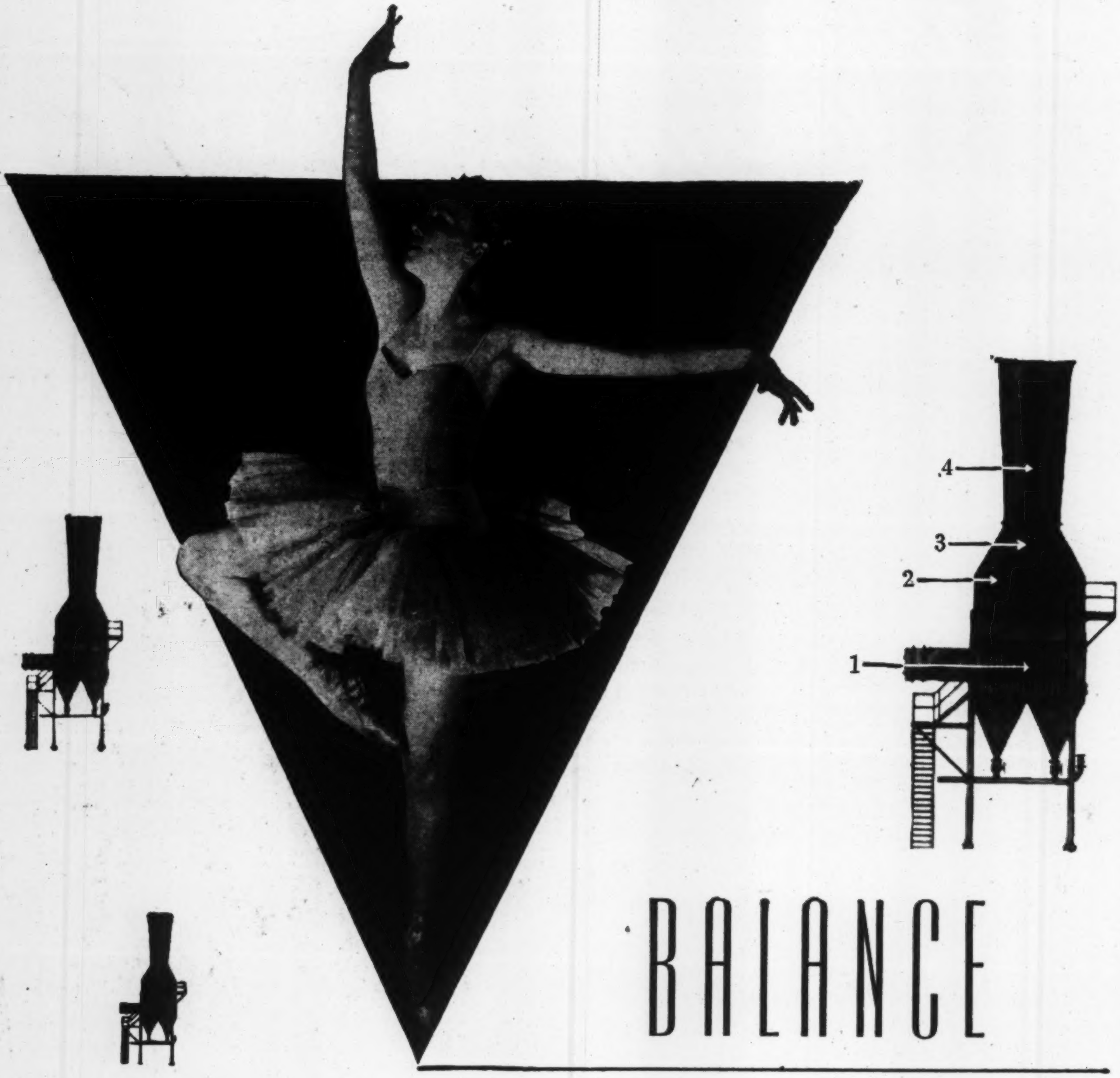

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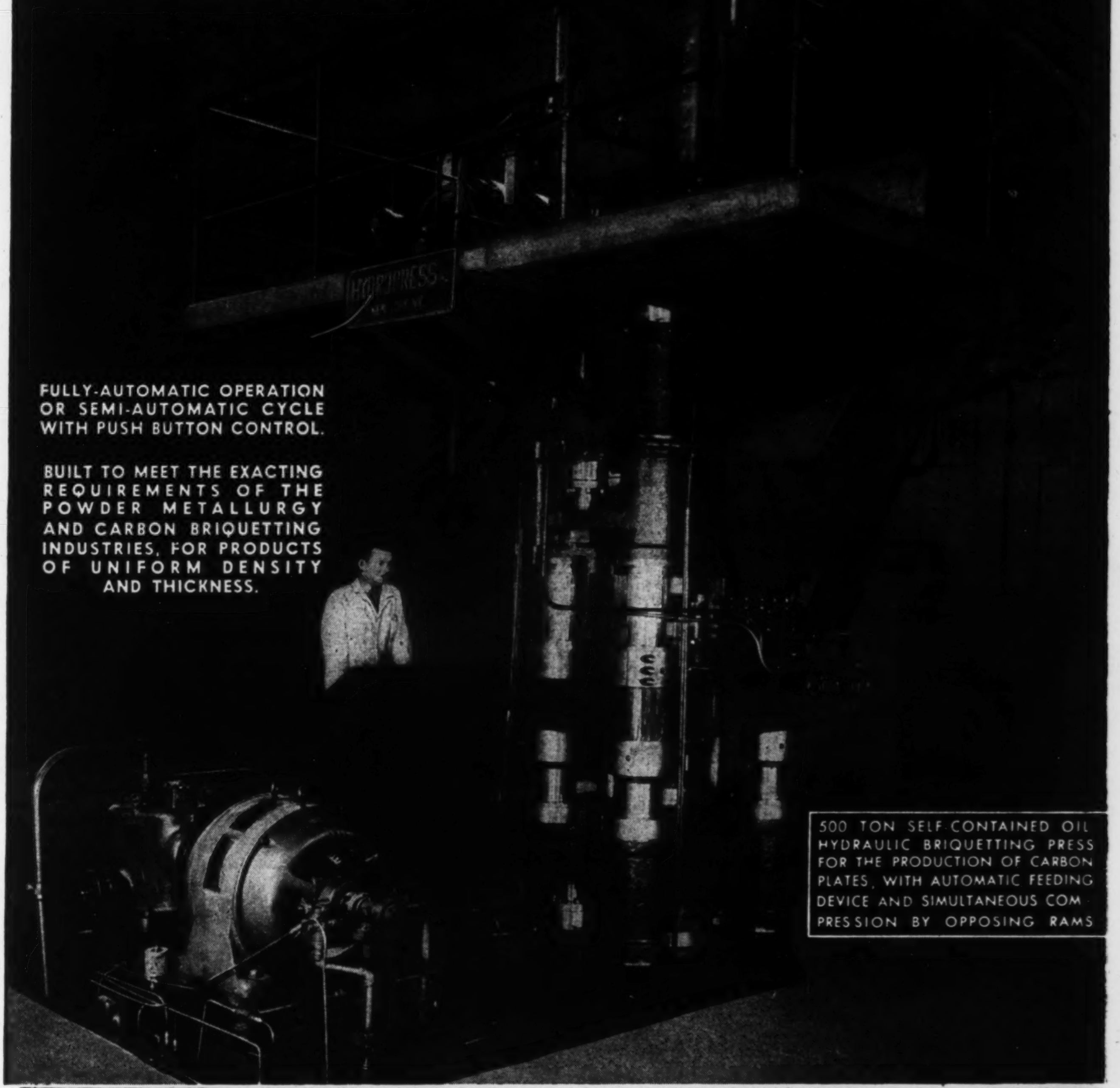

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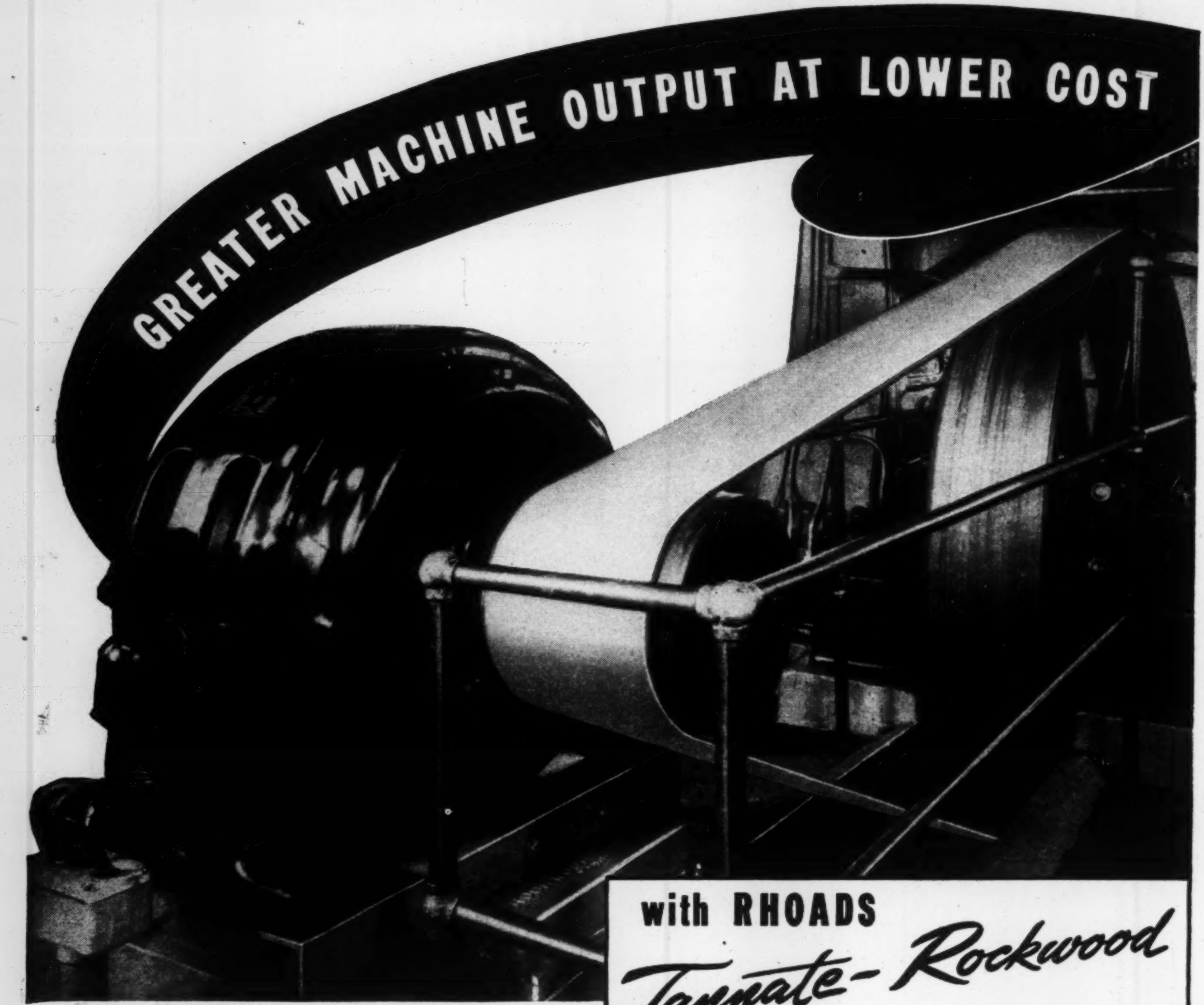

One of two identical units driving ammonia compressors, this 14" TANNATE belt has been in service more than 13 years—and is still running. Capacity of plant reported increased; power costs appreciably reduced.

with RHOADS

Tannate-Rockwood

SHORT CENTER DRIVE

TANNATE-ROCKWOOD Drives give you maximum output and full delivery of power at low cost over years of trouble-free operation. A minimum of maintenance is required.

The pivoted base assures correct belt tension for varying loads. The tough TANNATE belt carries high overloads and retains high efficiency.

Hundreds of TANNATE-ROCKWOOD drives in a great variety of applications have proven to the users that they are better than most other means of short center driving. For further information, consult our engineering department.

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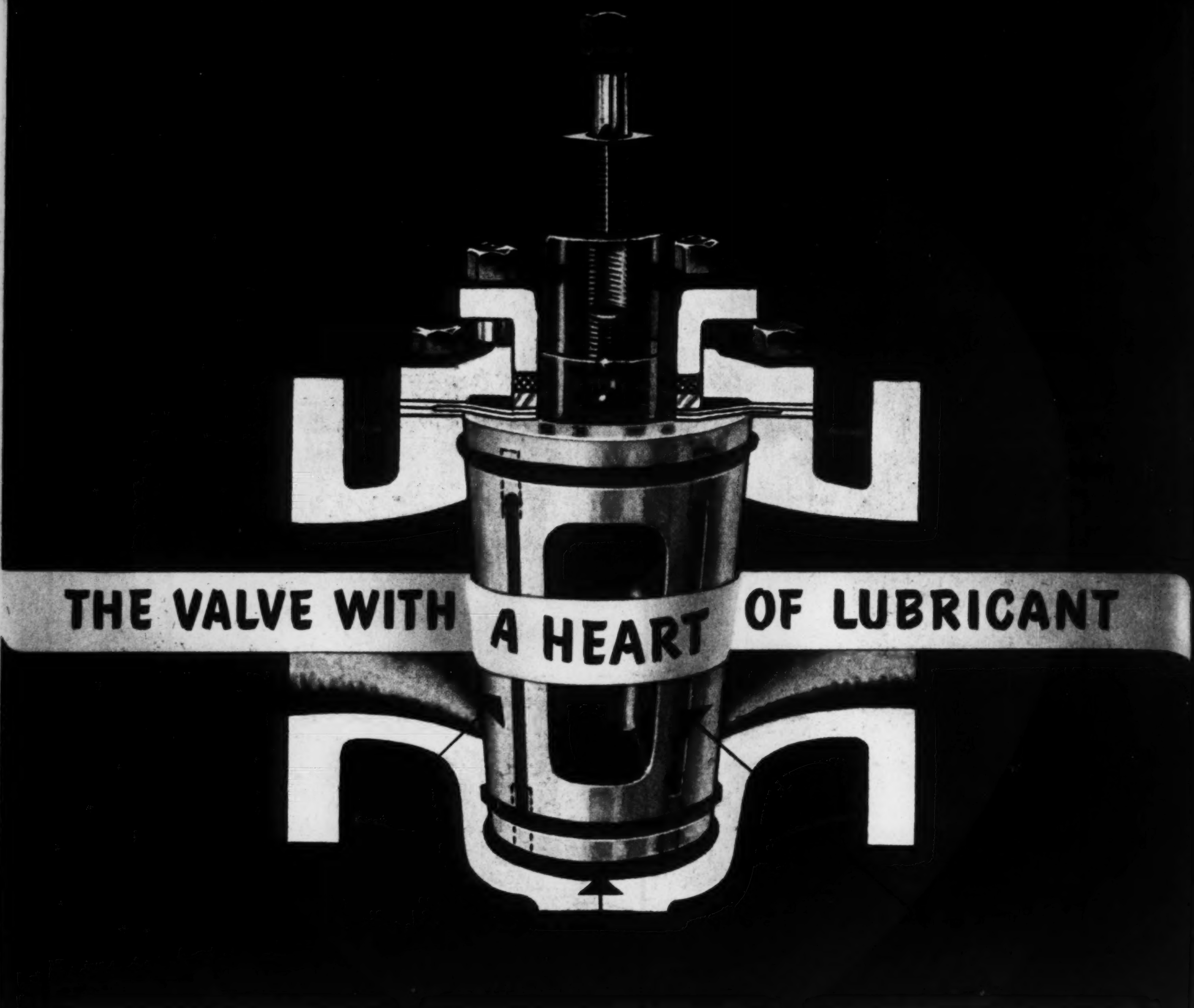
Hydraulic Packings and other Mechanical Leather Products

You can always count on Nordstroms for quick, tight shut-off
Nordstrom
LUBRICATED VALVES


THE VALVE WITH A HEART OF LUBRICANT

LUBRICATED SEAT

A film of lubricant is distributed between the tapered plug and its seat. This insures easy turning and protection against corrosion, erosion and intrusion of line material. Rotary plug prevents exposure of seats.

LUBRICANT JACKING CHAMBER

By turning the external lubricant screw, lubricant under pressure produces a jacking action on the plug. The thrust of the plug against the top shoulder stem seal gives resiliency.

POSITIVE SEAL AROUND PORTS

Grooves in plug, connecting with grooves in body, form an unbroken circuit around each port. Lubricant in the grooves prevents leakage past any part of the port boundry.

Something to think about before you buy valves

One "temperamental" valve on an important line in your plant or in the field might tie up your major flow of production. Check back in your experience and you can recall such instances. A single valve failure usually costs many times the price of the valve. Nordstrom valves are the "traffic controls" in well-engineered installations. They are literally the *heart* of the flow lines; easiest to switch flow; quickest to turn on or off; free from sticking; protected against leaks by "Sealdport" lubrication. The tapered plug is always seated. No sediment or deposits can creep in to prevent a tight closure. Nordstroms give line control not obtainable with any other type of valve. They are most economical in service. Buy them. Try them. *Performance is the proof.*

Keep Upkeep Down
Use *genuine*
Nordcoseal lubricants

Nordstrom

LUBRICATED ROCKWELL r **VALVES**

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NORDSTROM VALVE DIVISION—***Rockwell Manufacturing Co.***—400 No. Lexington Ave., Pittsburgh 8, Pa.

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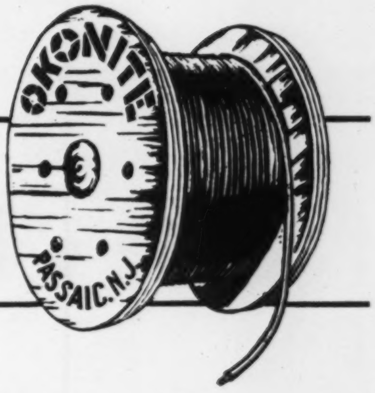
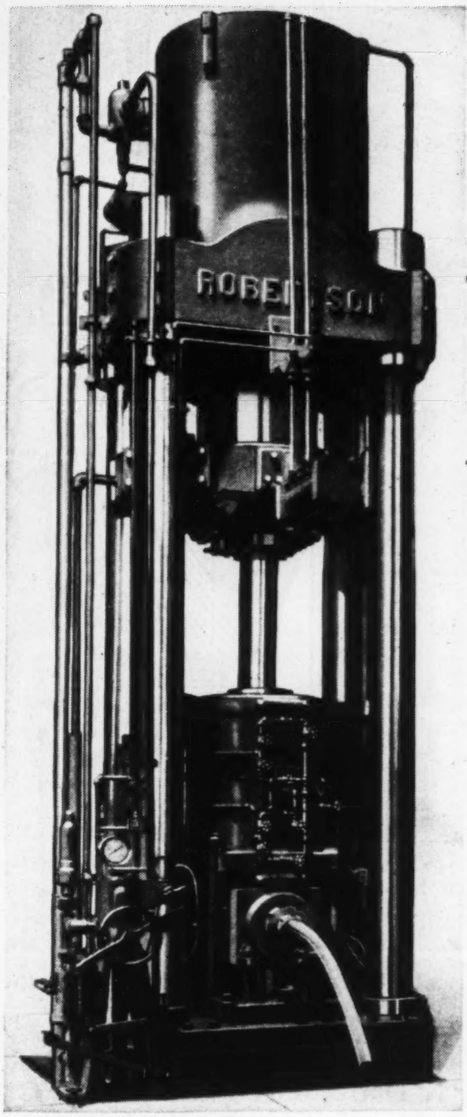
OKONITE





Uniformly steady output . . . low operating costs . . . and minimum maintenance are characteristic of Robertson Lead Encasing Presses and other Hydraulic Equipment. That's why leaders in the Wire and Cable Industry, like Okonite and many others, specify and use this equipment.

The knowledge and experience, of more than 90 years' specialization in the design and manufacture of high pressure hydraulic equipment, are at your service to help you solve your lead encasing problems. Consult us for detailed information.

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COMPANY INCORPORATED
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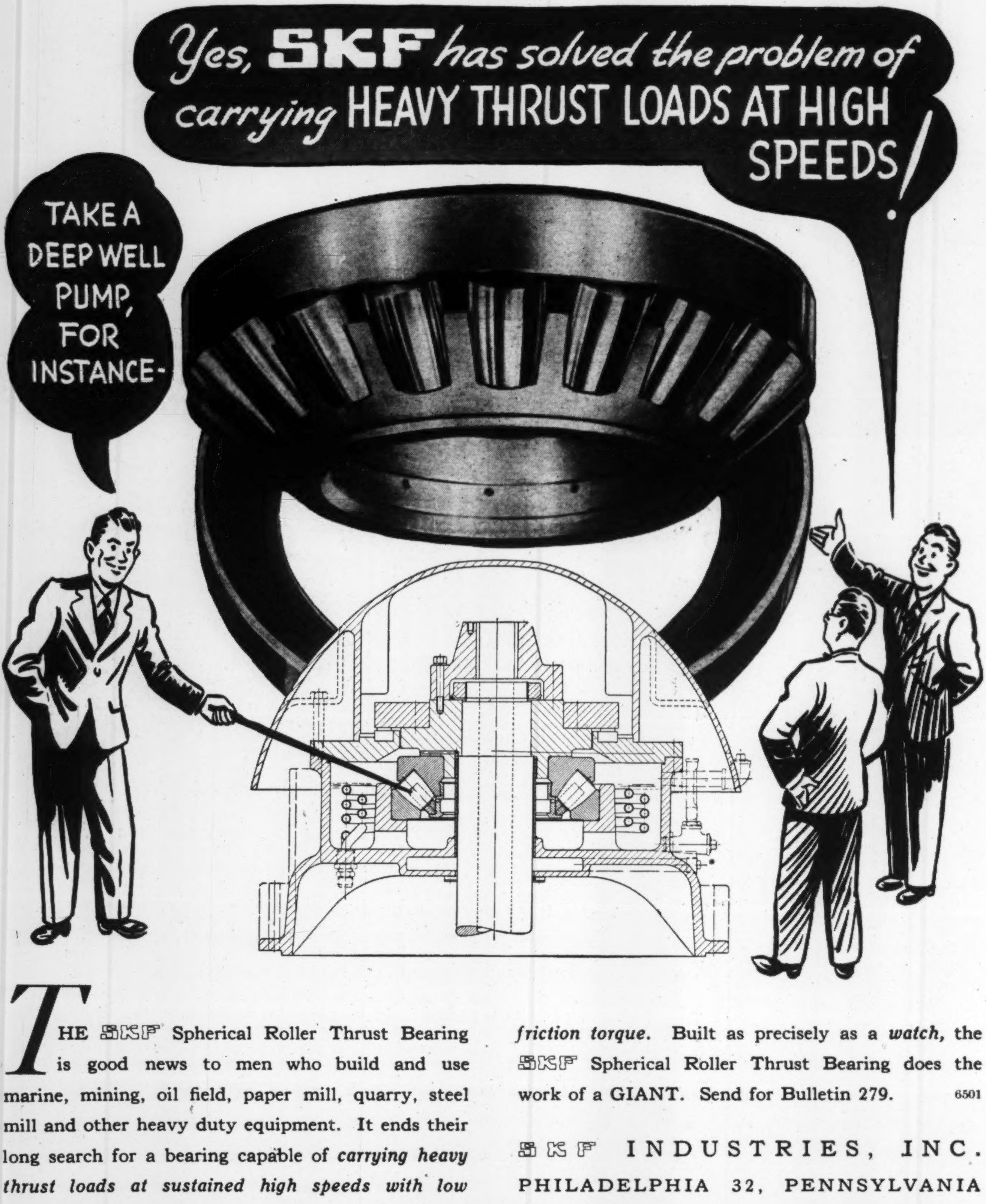
Yes, SKF has solved the problem of carrying HEAVY THRUST LOADS AT HIGH SPEEDS!
TAKE A DEEP WELL PUMP, FOR INSTANCE-

THE SKF Spherical Roller Thrust Bearing is good news to men who build and use marine, mining, oil field, paper mill, quarry, steel mill and other heavy duty equipment. It ends their long search for a bearing capable of *carrying heavy thrust loads at sustained high speeds with low friction torque.* Built as precisely as a *watch,* the SKF Spherical Roller Thrust Bearing does the work of a GIANT. Send for Bulletin 279. 6501

SKF INDUSTRIES, INC.
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1. THRUST CAPACITIES EXCEEDING 2,000,000 LBS.
2. ROLLING ALIGNMENT.

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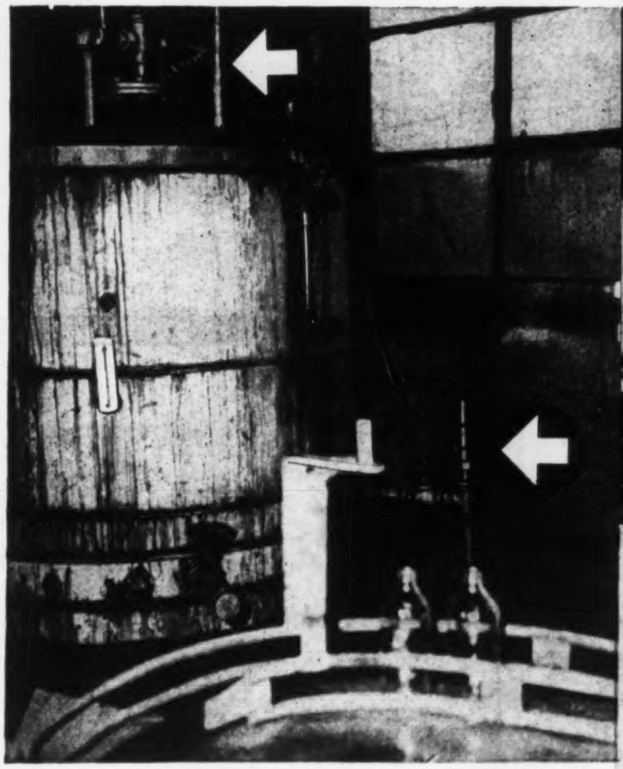
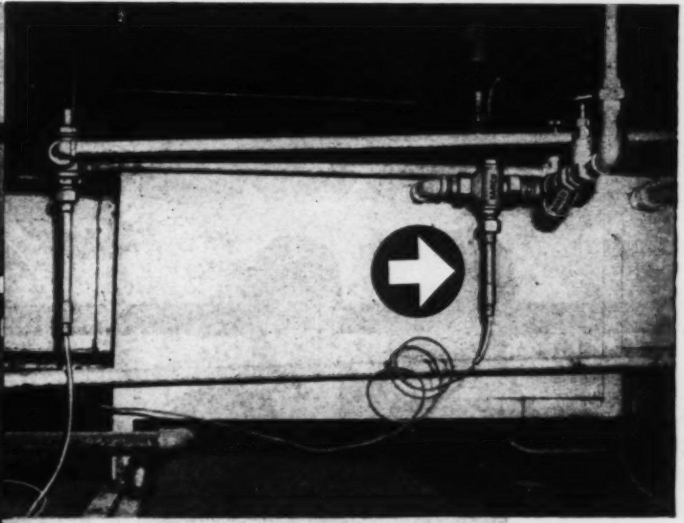
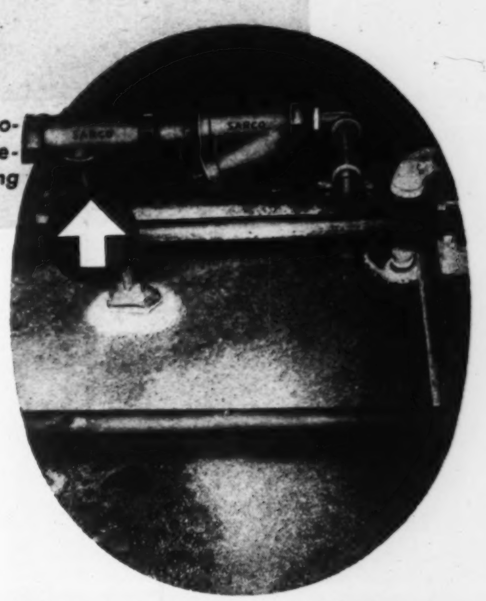




Sarco Controls on Proof Box in Bakery

Sarco 2430 Control on Vinegar Sterilizing Tank.



Sarco 87 Thermoton Reduces Rejects in Tin Plating Tank.

How Sarco REDUCES REJECTS...

Process heat is often applied toward the end of the production cycle. A rejected product at this point means lost materials, lost labor, and lost production—all gone forever with no salvage, as a rule.

Many hours of work are represented in the contents of the 1000 gallon per hour vinegar pasteurizer illustrated. Yet, with hand control the vinegar could scorch in a few minutes—or crack the jugs, and it did frequently.

In another part of this plant, old vinegar jugs are caustic-washed previous to being filled with commercial cleaning solution. Two out of six jugs were cracked with hand temperature control. Now all temperatures are controlled with Sarco—all products uniform, day in and day out, and spoilage is negligible.

Other Sarco controls are daily reducing the percentage of rejects in plating, baking (temperature and humidity controls) syrups and a hundred other chemical and food applications, and Sarco Steam Traps are reducing rejects in many industries by keeping heat up in every part of the coils.

231

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SAVES STEAM

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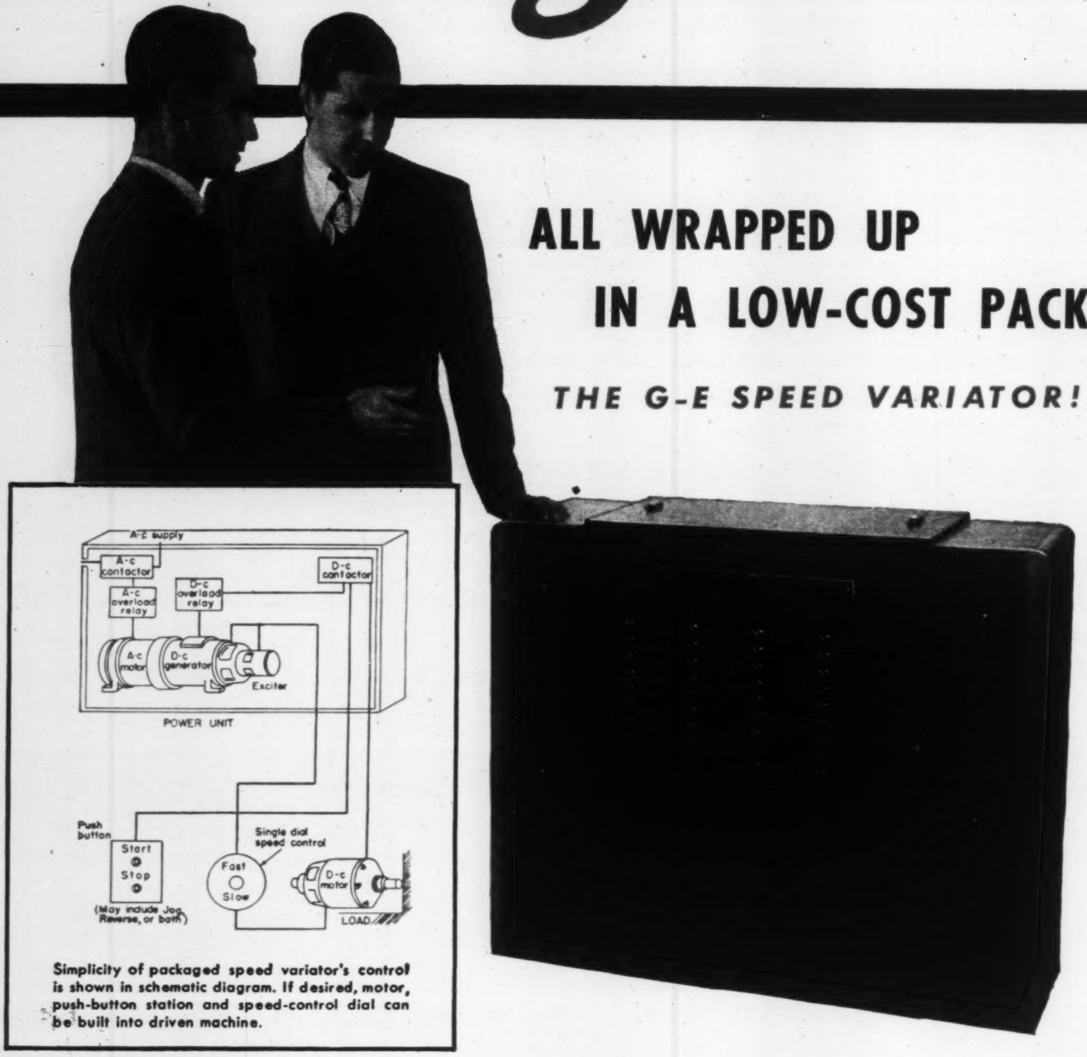
Designer's

ALL WRAPPED UP IN A LOW-COST PACKAGE

THE G-E SPEED VARIATOR!



A-c supply
A-c contactor
D-c contactor
A-c overload relay
D-c overload relay
A-c motor
D-c generator
Exciter
POWER UNIT
Push button
Start
Stop
(May include Jog, Reverse, or both)
Single dial speed control
Fast
Slow
D-c motor
LOAD

Simplicity of packaged speed variator's control is shown in schematic diagram. If desired, motor, push-button station and speed-control dial can be built into driven machine.

Now you can incorporate in your designs—at low cost—an adjustable-speed drive that gives the desirable performance of a d-c motor from an a-c power supply. With the G-E packaged Speed Variator, you can obtain smooth, flexible speed control over a 16 to 1 speed range. And because of mass production from standardized parts, you get an engineered system at an economical price, built for your particular application.

Longer life and lower maintenance costs are obtained from the new, compact, air-filtered power-unit case which encloses motor-generator set and control. Factory assembly and unit shipment reduce installation cost. Drive ratings of 3 through 60 hp are available. Ask for Bulletin GEC-280.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E PRODUCTS

FOR MACHINES WITH THE "SHAKES"

From the design standpoint, excessive vibration in moving machinery means trouble. With the G-E recording vibrometer, you can quickly find out the source and degree of vibration and provide for corrective balancing. This lengthens equipment life, saves design and maintenance costs. The vibrometer makes a permanent record of frequency, displacement, and waveshape in mechanical vibration. It records both steady-state and transient vibrations. Operation is simplicity itself. Just hold the prod extending from the vibrometer against the vibrating body, as illustrated. See Bulletin GEC-310.

TIME SWITCHES THAT "SAY WHEN"

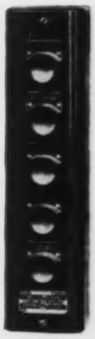
Here's the lowest-priced high-quality G-E time switch ever—the T-47. A "natural" for low-cost control of motors, heaters, lights, fans, blowers, and similar equipment, it automatically performs one "on" and one "off" operation during any 24-hour period, and repeats daily without further adjustment. It saves electricity, reduces losses due to negligence, and releases operators for other work. Available from stock. See Bulletin GEA-4874.

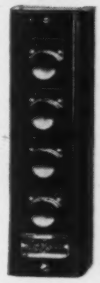
NEW! HANDY CONTROL BOOKLET

SIMPLIFIED GUIDE
A-C MOTOR CONTROL

You'll get a quick, helpful review of an important subject for machine designers in "Simplified Guide to A-C Motor Control." Here you'll find pointers on the various functions of control, how to select and apply the commonly used types, when and how to use magnetic and manual control, overload and undervoltage protection, enclosures, etc. See Bulletin GEA-4015.

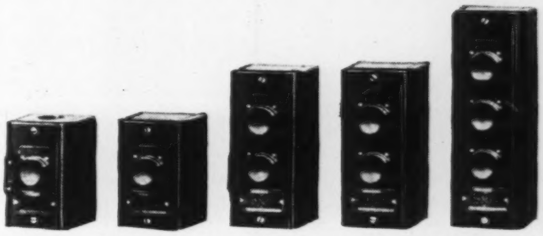
Off to a Good Start





Add the right touch to your machine designs with one of G.E.'s heavy-duty push-button stations. Designed for use with magnetic controllers, they're made for flush or surface mounting in general-purpose, dust-tight and watertight cases, and in enclosures for use in hazardous areas. Interchangeable units permit many combinations at one station of momentary and maintained contact buttons, selector switches, and indicating lights.

Sturdy, steel enclosures and ample electrical clearances assure operator safety. Large double-break contacts stand up under frequent operation. Installation of the surface-mounted stations shown is simple. Remove the cover and bolt to the desired surface through the mounting holes provided. Easily accessible terminals then make wiring a matter of seconds. See Bulletin GEA-5043.



General Electric Company, Section D668-66
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

☐ **GEC-280—Packaged speed variator**
☐ **GEC-310—Recording vibrometer**
☐ **GEA-4874—T-47 time switch**
☐ **GEA-4015—A-c motor control guide**
☐ **GEA-5043—Push-button stations**

YOUR McGRAW-HILL ELECTRICAL CATALOGS show "everything electric" for machinery manufacturers in the G-E section.

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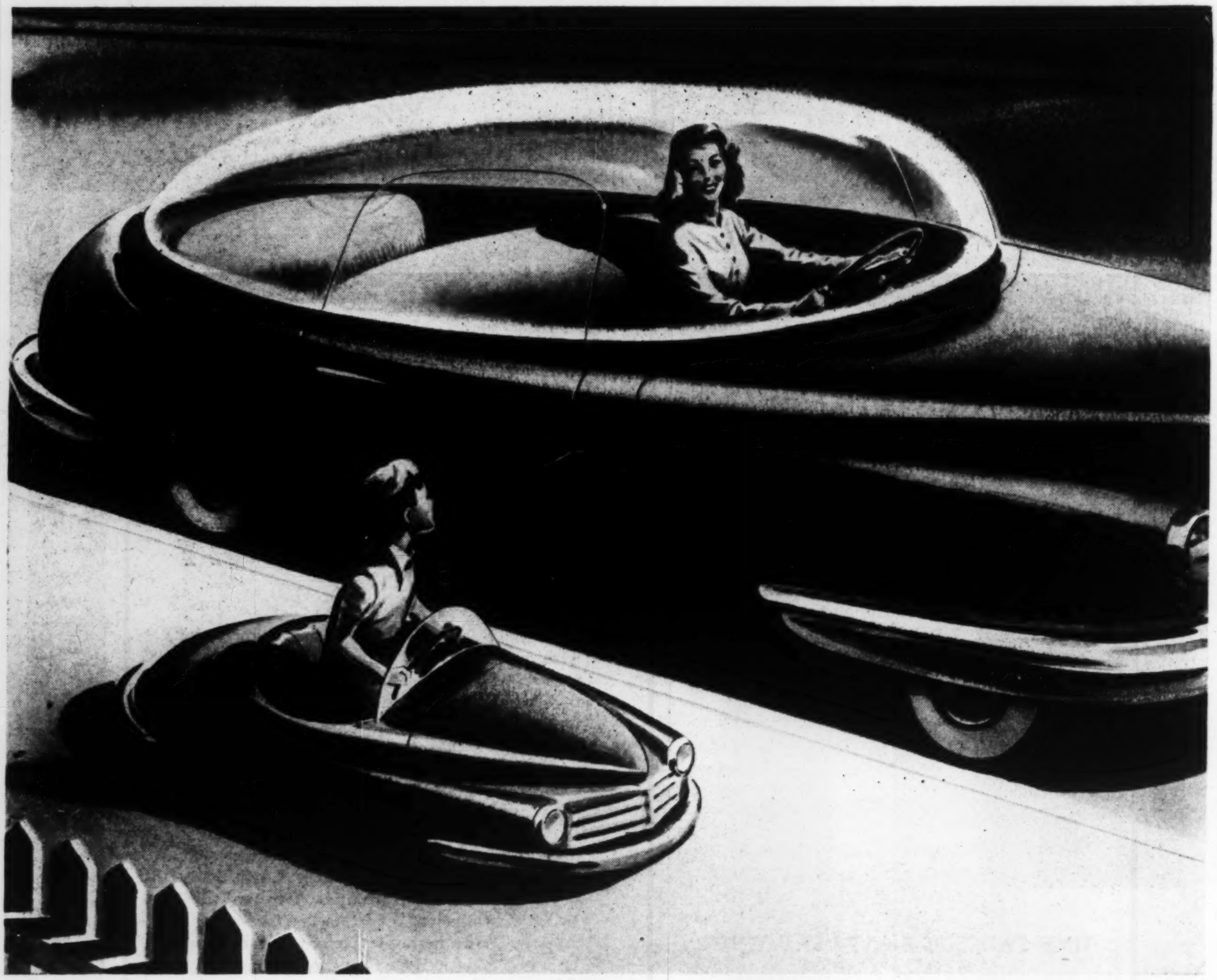

Spongex gives both a smoother ride

FROM TOY auto tires to more than a dozen places in your own new car, *Spongex* sponge rubber is being used to make life smoother and easier for everyone.

In homes, offices and factories . . . in land, sea or air travel . . . wherever you go, whatever you do today, your path is made pleasanter by *Spongex* as an integral part of more and more widely varied products.

Spongex is used for seals on iron lungs and incubators; for weather strip and rug cushions; for typewriter key pads and refrigerator insulation — an infinite number of things, increasing almost daily.

Made by a company which has specialized for 25 years in the production of cellular rubber products, *Spongex* is an amazingly versatile material that is being used by leading manufacturers to solve problems of cushioning, sealing, insulating, gasketing, dust-proofing, shock absorption, and for sound and vibration elimination.

Give this unique material your serious consideration when planning improvements of your present products or developing new ones for future production. Samples available for experimental purposes. Sponge Rubber Products Co., 129 Derby Place, Shelton, Conn. Sales Offices in principal industrial centers.

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SPONGE RUBBER PRODUCTS CO.

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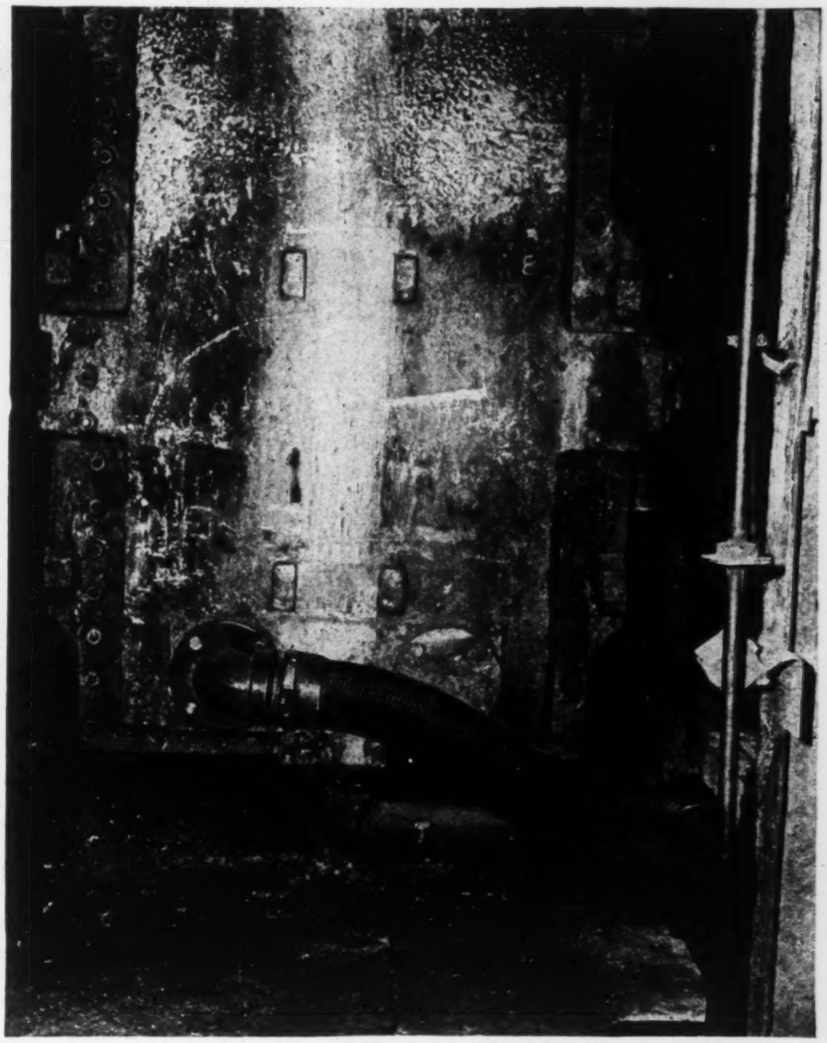

This American Seamless Flexible Connector leads a hard life on a water-cooled mold in the brass casting shop of the Winchester Repeating Arms Company plant at New Haven, Conn.

AMERICAN SEAMLESS

takes knock-down-and-drag-out routine at Winchester Repeating Arms Casting Shop

Here a troublesome problem is solved with American Seamless Flexible Bronze Tubing, 3" I.D., strengthened with a covering of bronze wire braid. We supplied it with special couplings soldered on.

By substituting this rugged flexible metal connector for the original rigid line, Winchester engineers eliminated time lost in connecting and disconnecting this mold after every cast. In handling spent coolant water at 140° F. and 75 to 100 lb. pressure, this connector retains its flexibility despite the spatter of molten brass.

If you have a problem in conveying water, steam, oil or other liquids, semi-solids or gases; in meeting misalignment, eliminating vibration, connecting moving parts, or piping in cramped places, "American" engineers can help you. They will design connections to fit your job, complete with special end fittings. *No extra charge* for our engineering service.

There are many types of American Seamless Flexible Metal Tubing and Flexible Metal Hose for many uses. Write for information and feel free to consult our Technical Department at any time.

48204

ANACONDA
from mine to consumer

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METAL HOSE
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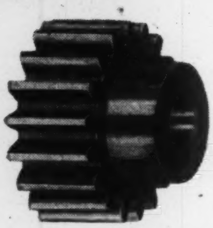
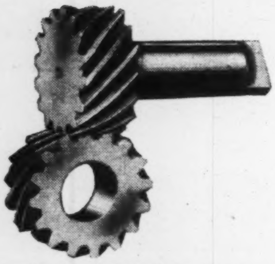
PHILLIE GEAR

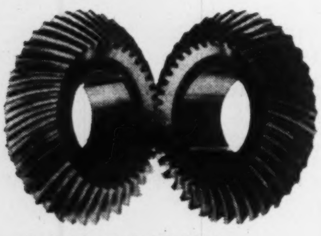


Spur Gears up to 150" diameter (one piece). Bolted section gears even larger.

Bevel Gears up to 96" diameter.



Spiral and Helical Gears up to 150" diameter.



Curved Tooth Spiral-Bevel Gears up to 48" diameter.

We *believe* there is merit in "sticking-to" one line of business for over a half century, and we *know* that there is deep satisfaction in growing year-after-year, particularly when that growth reflects user confidence and continued patronage.

Today, we have one of the largest and most modern plants in America devoted to the design and manufacture of Gears for Industry and Transportation. In fact, there is no type, size, or quantity of gear which we do not make, and that is just why we have been known for years as *"Gear Headquarters."*

Write for your copy of our latest 68-page *"Gear Book,"* and please use your Business Letterhead when requesting it.

Philadelphia Gears

Philadelphia Gear Works, INC.

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Industrial Gears and Speed Reducers
LimiTorque Valve Controls

For BETTER TEMPERATURE CONTROL

POWERS
No. 11 Regulators

GET A COPY OF NEW BULLETIN 329

It will help make it easy for you to select the simplest, most dependable type of control made for many of the following applications.

Water Heaters and Hot Water Line Control • Fuel and Crude Oil Heaters • Cooling water for Compressors, Diesels, Gas Engines and Transformers • Sprinkler Tank Heaters • Steam Heated Tanks, Vats, Dryers and Kettles • Dishwashers, Steam Tables and Coffee Urns • and many other uses. (11DG)

Quickly Pay Back Their Cost

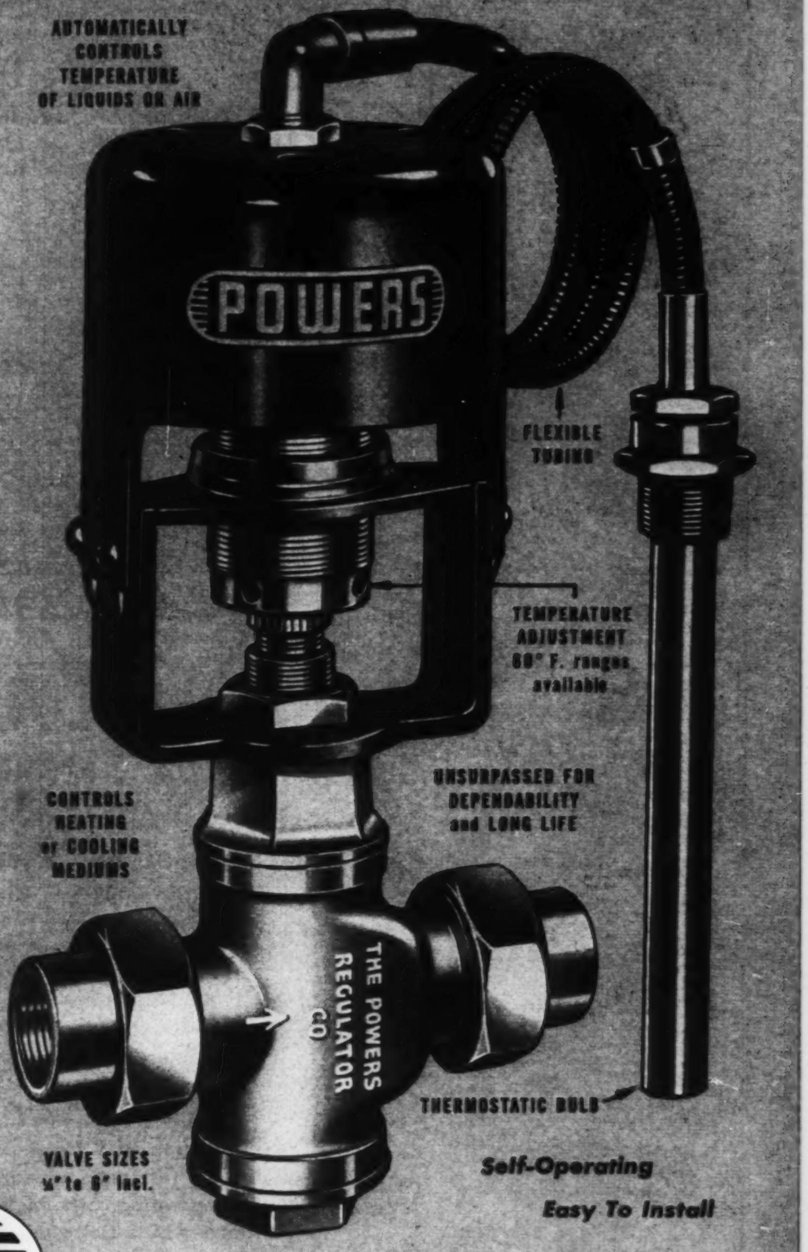
Controlling heating operations they prevent OVER heating—save fuel and labor—improve production

Controlling cooling water for diesel, gas engines and compressors they help prevent OVER and UNDER cooling—increase operating efficiency and reduce consumption of cooling water

TYPES AVAILABLE: Direct and reverse acting regulators—Double Seat balanced valve, double unions ½" to 2" incl., flanged 2½" to 6" incl.—Single Seat valve double unions ¼" to 1½" incl.—3-Way valve ½" to 4" incl.—Temperature Indicating regulator—all are shown in new Bulletin 329. Get a copy and prices from our nearest office.

Use

POWERS


AUTOMATICALLY CONTROLS TEMPERATURE OF LIQUIDS OR AIR
POWERS
FLEXIBLE TUBING
TEMPERATURE ADJUSTMENT 60° F. ranges available
UNSURPASSED FOR DEPENDABILITY and LONG LIFE
CONTROLS HEATING or COOLING MEDIUMS
THE POWERS REGULATOR CO
THERMOSTATIC BULB
VALVE SIZES ¼" to 6" incl.

Self-Operating

Easy To Install

No. 11 REGULATORS

When you want a simple, rugged control to maintain a constant temperature with unfailing dependability . . . install a POWERS regulator. They often give 10 to 25 years of service and pay back their cost several times a year. No compressed air or electricity required. May be just the regulator to solve some of your temperature control problems. ***Write for Bulletin 329.***

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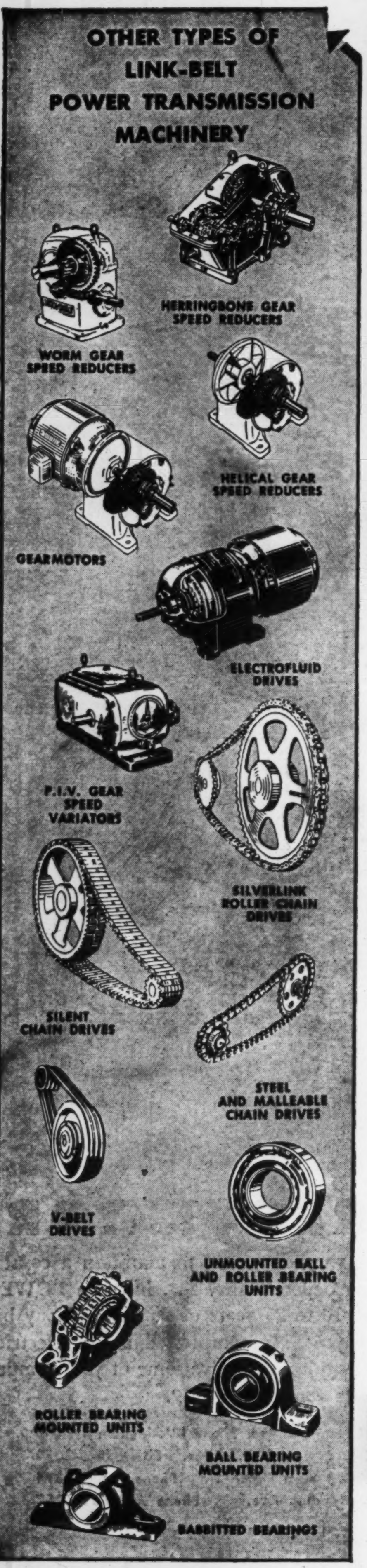
Over 55 Years of Temperature and Humidity Control

POWERS
EASY TO READ
DIAL THERMOMETER
INDICATES
TEMPERATURE

No. 11 INDICATING REGULATOR

Combining an easy to read dial thermometer with a self operating regulator was pioneered by POWERS in 1930. Thermometer has a 4" dial and is mounted on top of the regulator. Both thermometer and regulator operate from same thermal system. Only one tapped opening required. A visual check on performance of the regulator is provided and it is easy to adjust for different temperatures.


OTHER TYPES OF
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POWER TRANSMISSION
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UNMOUNTED BALL AND ROLLER BEARING UNITS
ROLLER BEARING MOUNTED UNITS
BALL BEARING MOUNTED UNITS
BABBITTED BEARINGS

STEADY STREAM of POWER
to this PUG MILL . . .

from LINK-BELT *Silverlink*
--- ROLLER CHAIN DRIVE

Pushing clay through this pug mill takes power, plenty of it, and a steady push. Slippage is out of the question on such applications, so Denver Fire Clay Company chose Link-Belt Silverlink roller chain and an L-B herringbone gear reducer for this important job. They obtain positive power transmission, plus assurance of long life, minimum upkeep, and lower year-by-year costs.

Plant engineers and production executives in every industry faced with the need for increased production and lowered costs, will appreciate the old fashioned advantages of low investment, low operating costs, high efficiency and long life found in Link-Belt chain and enclosed gear drives.

Consult Link-Belt power transmission engineers on any problem of mechanical power transmission.

Silverlink is an accurately made finished steel roller chain of high tensile strength and excellent wear value made to ASA standards for power transmission at either high or low speeds. Widely used on all types of machinery for drives and conveyors. Made in pitches ⅜" to 3" in single and multiple widths for drives to 1000 H.P. and above and various attachments for conveyor applications. Stock sizes.

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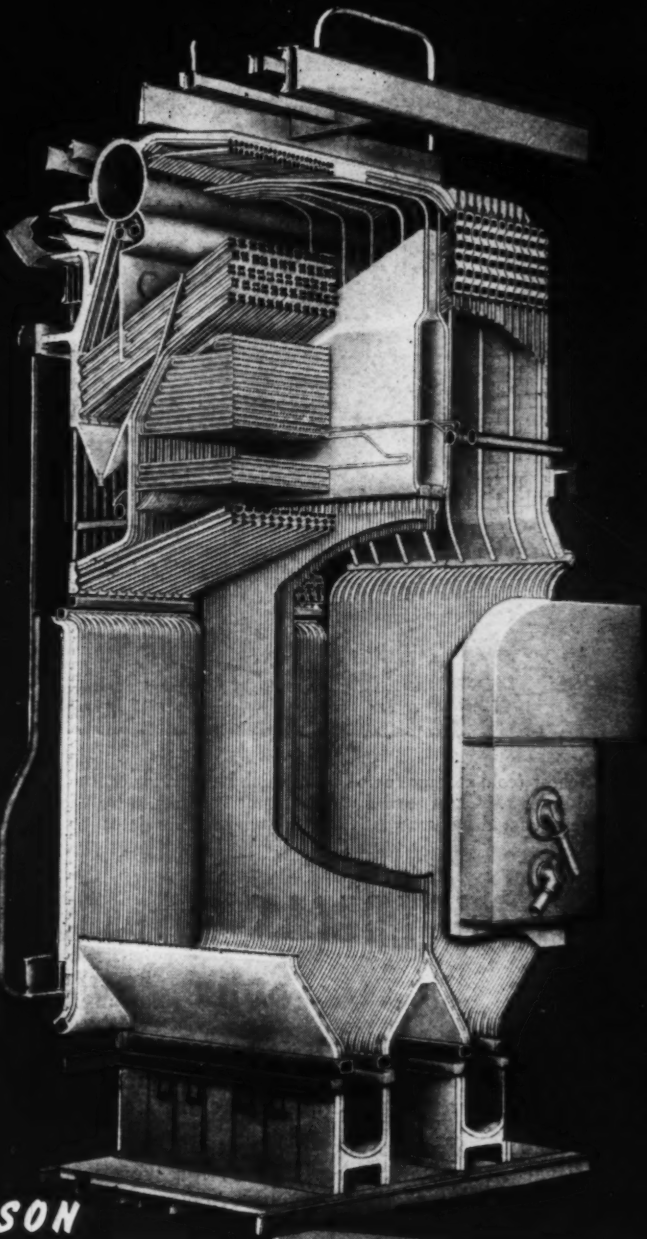
LINK-BELT

Power Transmission Machinery

For Heavy Duty Steam Generating Plants

Springfield's

DIVIDED FURNACE WITH CENTER WATER WALL



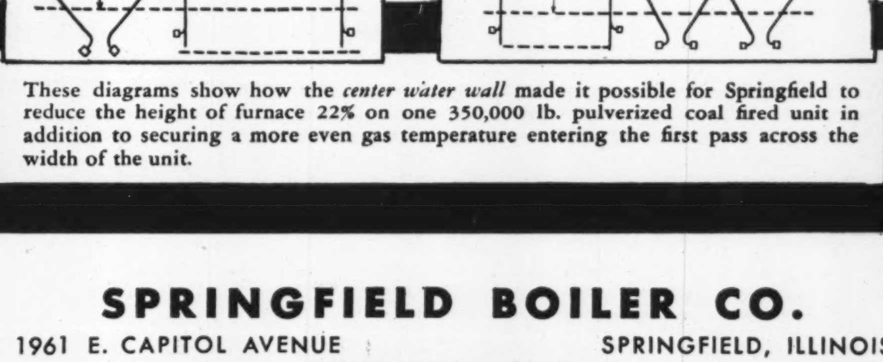
THE divided furnace with a CENTER WATER WALL* is a development first introduced by Springfield Boiler Co., for large central station installations. It has application where gas temperatures entering the first pass and superheater must be limited to prevent overheating of the center section of the wider furnaces. It enables a unit to stay on the line longer before shutting down for maintenance and cleaning.

The divided furnace construction has been highly dependable and successful in service. It is adaptable to any kind of firing. Springfield offers it on both bent tube and straight tube boiler designs.

*Patented

CHECK WITH YOUR CONSULTING ENGINEER ON YOUR MODERNIZATION AND NEW PLANT PROJECTS

A COMPARISON



CONVENTIONAL FURNACE

FURNACE WITH CENTER WATER WALLS

These diagrams show how the *center water wall* made it possible for Springfield to reduce the height of furnace 22% on one 350,000 lb. pulverized coal fired unit in addition to securing a more even gas temperature entering the first pass across the width of the unit.

SPRINGFIELD PRODUCTS

BENT TUBE STEAM GENERATORS—Modern designs for capacities from 10,000 lbs. up.

STRAIGHT TUBE BOILERS—Specially designed for capacities from 5,000 to 450,000 lbs. per hour and higher.

STANDARDIZED TYPE M BOILERS—Standardized for quicker delivery and lower cost. Sizes 6,000 to 17,000 lbs. per hour.

WATER COOLED FURNACES—Heavy duty water walls. Exclusive center water wall construction for larger units.

SUPERHEATERS — AIR HEATERS — ECONOMIZERS—Individually designed to meet requirements.

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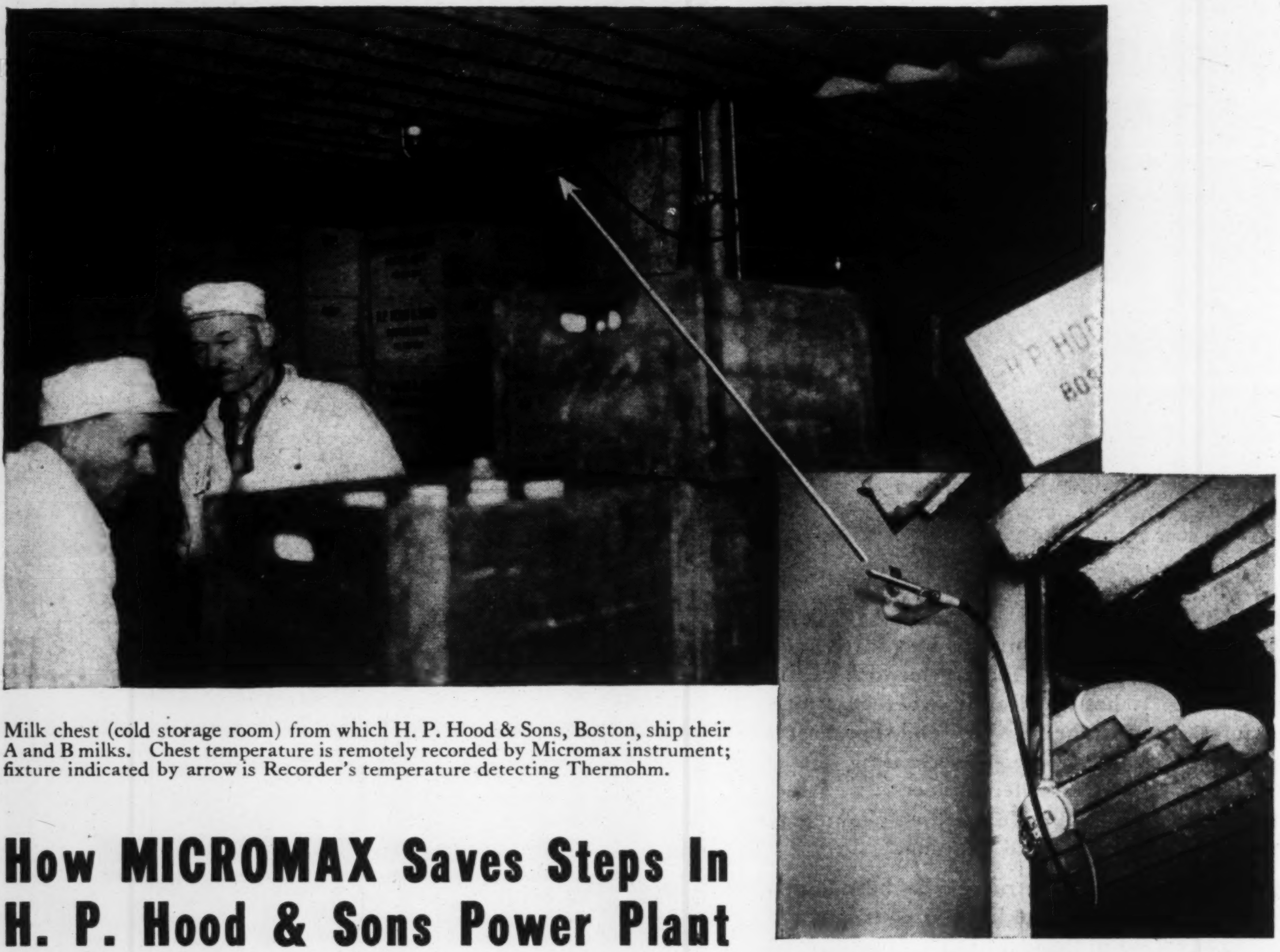
See our catalog in SWEET'S



Milk chest (cold storage room) from which H. P. Hood & Sons, Boston, ship their A and B milks. Chest temperature is remotely recorded by Micromax instrument; fixture indicated by arrow is Recorder's temperature detecting Thermohm.

How MICROMAX Saves Steps In H. P. Hood & Sons Power Plant

"It saves us a thousand steps an hour," says the chief engineer of H. P. Hood & Sons, referring to the Micromax Recorder which charts temperatures of storage chests in the milk plant.

Formerly, when mercury or spirit thermometers were used for temperature checks, much time and effort went into the continuous trek from chest to chest. Even so, engineers had only an intermittent guide to correct refrigeration.

Now, the Micromax Recorder, located right in the power plant, gives an accurate record for all chests, so that off-temperature is a thing of the past. Thus stocks are safer, because temperature can be kept more strictly within limits. Fuel is saved, since there is no longer any need to over-refrigerate.

The Recorder used is a multiple point instrument, capable of recording as many as 16 readings, for near or distant chests. The Thermohms (electrical resistance thermometers) which do the detecting, are ideal for "low" temperatures, retaining sensitivity and requiring minimum maintenance under any refrigerating conditions. If damaged, a Thermohm or its leadwire can be replaced without affecting the instrument's calibration.

Bring your refrigerating-temperature problem to the attention of our engineers, or if you prefer, request Catalog N-33C. Leeds & Northrup Company, 4963 Stenton Ave., Philadelphia 44, Pa.

"Hood" power-plant engineer logs temperatures of milk chests, reading the multiple point record kept by the Micromax Recorder. Installed in the plant's powerhouse, Recorder is conveniently located within 25 ft. of valves, making prompt, exact control possible.

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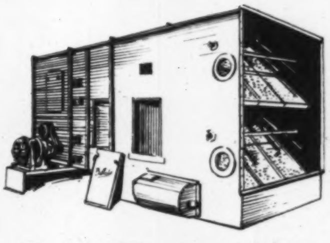
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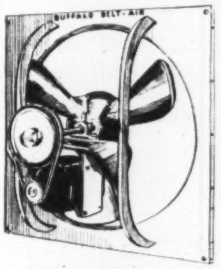

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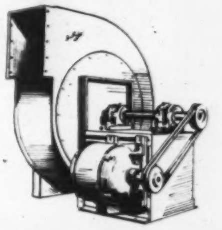
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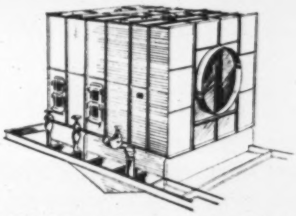
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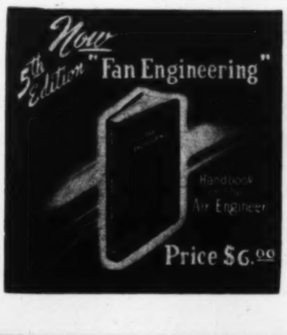

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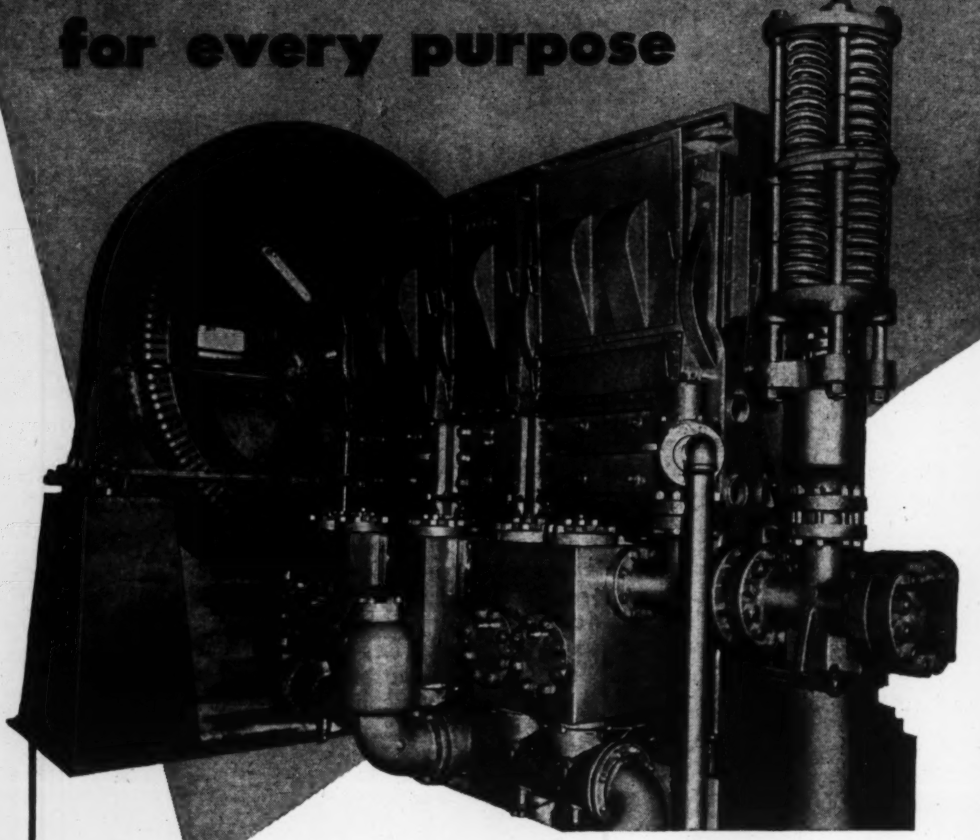

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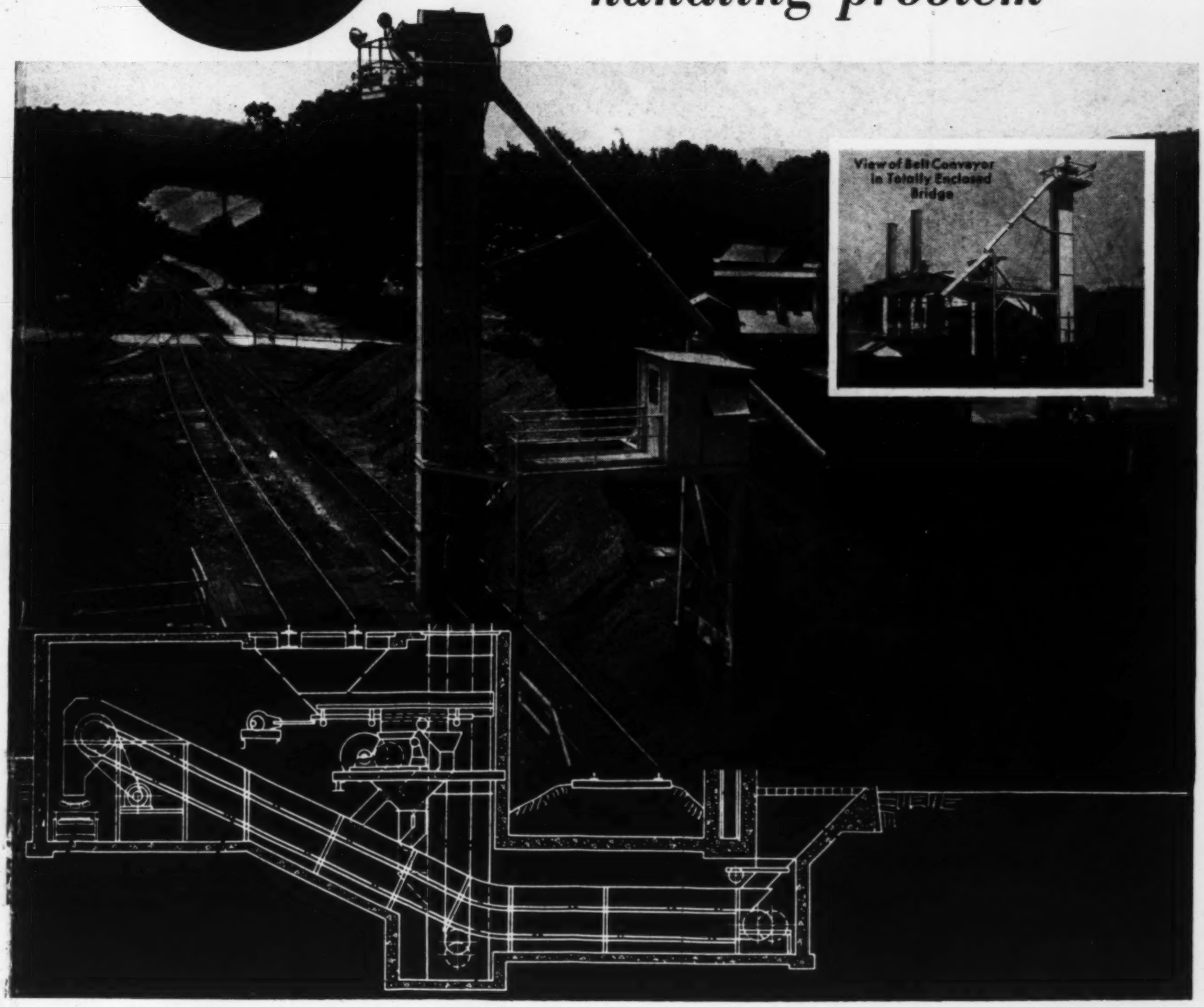

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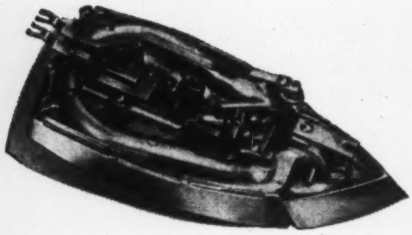

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 70 NUMBER 12

Contents for December, 1948

THE EDUCATION OF PROFESSIONAL STUDENTS FOR CITIZENSHIP . . . *E. D. Smith* 959
ENGINEERING IN AN ERA OF BIG SCIENCE AND BIG BUSINESS . . . *Wilson Compton* 963
DEVELOPMENTS IN BURNING PULVERIZED COAL . . . *F. L. Dornbrook* 967
THE STATUS OF HIGH-SPEED DIGITAL COMPUTING SYSTEMS . . . *H. D. Huskey* 975
ENGINEERING RESEARCH . . . *L. M. K. Boelter* 978
TOOLS AND TECHNIQUES OF MANAGEMENT . . . *R. W. Elsasser* 979
STYLING AND THE MECHANICAL DESIGNER . . . *E. D. Hay* 983
USE OF A TECHNICAL LIBRARY . . . *R. H. Whitford and J. B. O'Farrell* 987
ECPD ANNUAL MEETING . . . 994
THE NEW LOOK IN ECONOMICS . . . *E. C. Brown* 996

EDITORIAL . . . 957
BRIEFING THE RECORD . . . 998
ASME TECHNICAL DIGEST . . . 1012
CONTENTS OF ASME TRANSACTIONS . . . 1021
COMMENTS ON PAPERS . . . 1022
REVIEWS OF BOOKS . . . 1024
ASME BOILER CODE . . . 1029
THE ENGINEERING PROFESSION—NEWS AND NOTES . . . 1030
ASME NEWS . . . 1036
ASME JUNIOR FORUM . . . 1041

INDEX TO ADVERTISING PAGES . . . 112

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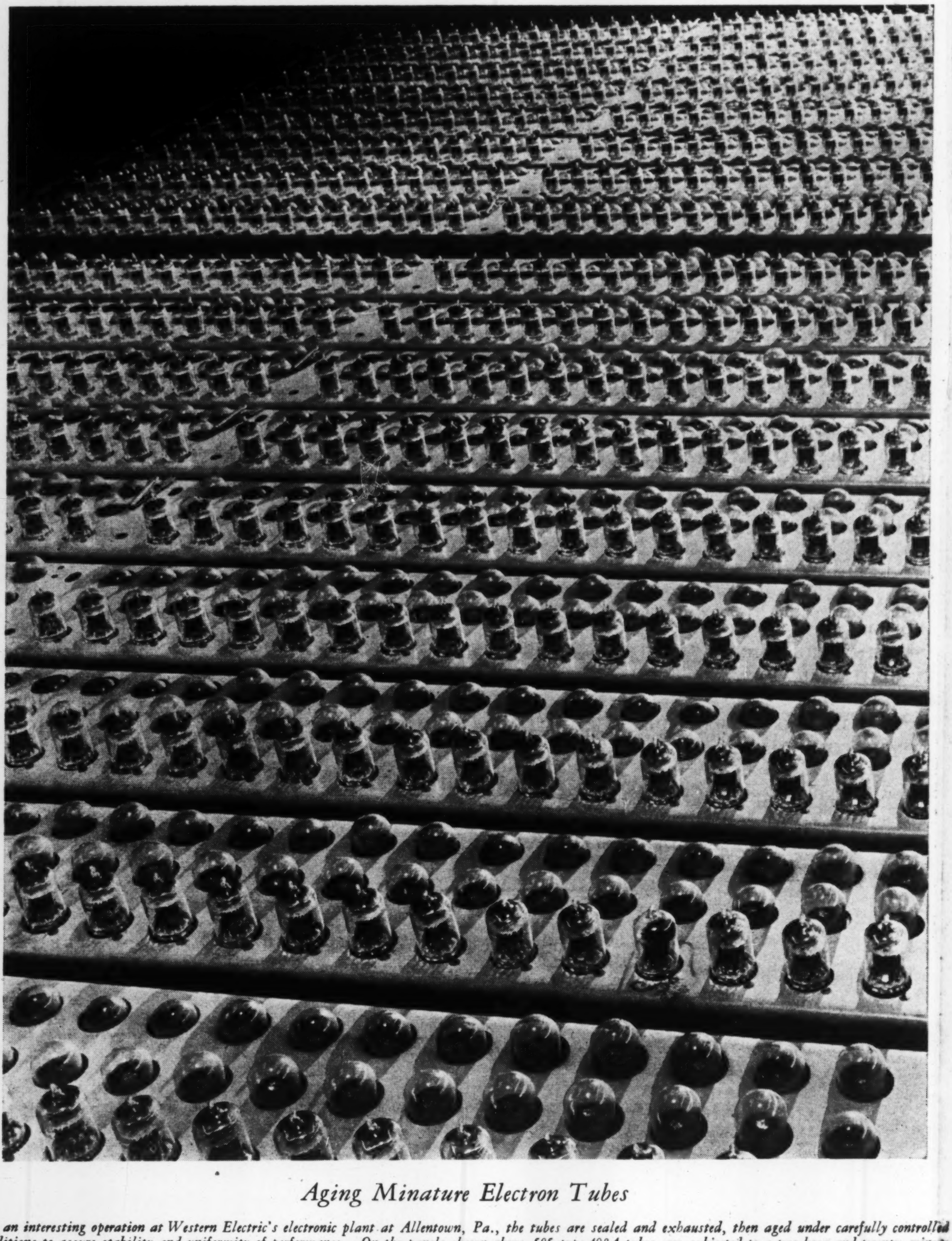

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(In an interesting operation at Western Electric's electronic plant at Allentown, Pa., the tubes are sealed and exhausted, then aged under carefully controlled conditions to assure stability and uniformity of performance. On the panels shown above, 595 type 408A tubes are subjected to a two hour and twenty minute aging cycle. See page 1005 of this issue.)

VOLUME 70
No. 12

MECHANICAL ENGINEERING

DECEMBER
1948

GEORGE A. STETSON, *Editor*

150 Years of Science

IN July, 1948, the *Philosophical Magazine* (London), first published in 1798, issued a commemoration number to mark the 150th anniversary of its foundation. By means of a group of special articles the progress of natural philosophy is traced through the eighteenth century, and thus a background is laid for the developments in pure and applied science which distinguished the last century and a half. These developments the editors of the magazine and the scientists who recorded and interpreted them passed on to the intelligent readers of their time whose lives and fortunes were being influenced by the advances made. Looking backward from the current vantage point of the mid-twentieth century, the reader is impressed by the hesitant and irregular steps, some of them spent in aimless wandering along false trails, by which men have moved toward an understanding of the physical world in which they live, and feels humble and grateful in the presence of the more successful pathfinders.

A majority of persons of every generation, and ours is no exception, accept without question the current dogmas relating to natural phenomena and their significance. They are quick to distinguish truth from falsehood among the ideas held by the ancients. As each new scheme of systematic and orderly explanation of a branch of the natural sciences wins wide acceptance, they are likely to hail it as ultimate truth, at last revealed and set free from the bondage of ignorance and superstition. But among the ideas thus invested with the authority of truth itself, subsequent generations find much dross and the error which results when a theory that appears valid in a special and limited case is extended to include all cases, attempts to offer an explanation of universal fundamentals, or runs afoul of the implications of extrapolation. Certainly the contemporaries of Einstein, Rutherford, Heisenberg, and others, witnessing the confusion of what has been called the "cocksure" school of physicists of the turn of the present century, will tincture their faith in current science with a reasonable doubt that it is, at last, the revelation of the ultimate truth and will find more to admire than to scorn in the science of the eighteenth century. Even though the geometry of Euclid and the mechanics of Newton may serve the engineer of today as faithfully in many cases as they did Rennie and Telford and Watt. The fields of the ultralarge and the ultrasmall in respect to dimensions, motions, pressures, temperatures, energies, and the like, confront him with the need of consulting more modern teachers.

It may be questioned whether we may not have lost something of larger significance when we substituted physical science for the more general term, natural philosophy. For there are in the connotations of the word philosophy certain values which broaden the significance of science as it has been used in its more restrictive sense by members of the cocksure school. Its literal meaning, love of wisdom, has a more noble implication than does the original use of the word science, the possession of knowledge. In modern usage the words are applied to different areas and to different techniques. There are many examples of philosophers who were scientists and scientists who were philosophers and the number is growing. Ultimately, it seems necessary that the two must merge as the one extends its techniques and the other the area of its studies. Probably if the original editors and publishers of the *Philosophical Magazine* were to start their venture today they would use the word "scientific." But 150 years of publication have preserved for us the name chosen in 1798, and there it stands as a bridge between the past and the present and a symbol of the hope of all intelligent men that wisdom may come with knowledge and all departments of human knowledge may be co-ordinated in a unified whole.

Unless science and philosophy, knowledge and wisdom, advance us toward these ends, they can have little value to us, either as a race possibly destined to ultimate distinction on this planet or as individuals suffered to experience a few brief years of physical existence.

The "Philosophical Magazine"

THE *Philosophical Magazine* is not an organ of a scientific society but a periodical issued by an independent and private publishing house. It was founded by Alexander Tillock a "prominent figure in the contemporary world of invention and printing." The firm of printers and publishers of the magazine, Taylor & Francis, Ltd., derives its name from Richard Taylor (1781–1858) and William Francis, who was born in 1817 and became Taylor's partner in 1852. Richard Taylor, whose name first appears on the title page of the magazine in 1800 as a member of the firm of Davis, Taylor, and Wilks, "was a man of wide learning and liberal views." He was a competent classical scholar and "played a large part in the foundation of the City of London School and of University College and he did much for the corporation library." In 1822 he became joint editor with Alexander Tillock of the *Philosophical*

Magazine and in 1822 "he initiated, with the help of William Francis, a journal which in 1841 became the *Annals and Magazine of Natural History*." Dr. William Francis, after study at University College, London, "went to Berlin and later to Giessen, where he worked on the salts of molybdenum under Liebig and graduated Ph.D. in 1842."

In addition to Tillock, Taylor, and Francis, the list of editors of the magazine contains the names of such distinguished scientists as Sir David Brewster, John Tyndall, Lord Kelvin, Sir J. J. Thomson, John Joly, Sir Lawrence Bragg, and Sir George Thomson. The last two, with Allan Ferguson, constitute the current editorial board. Among the long list of contributors to the *Philosophical Magazine* are to be found: H. A. Rowland, who "could find no American journal which would accept his first scientific paper;" Sir William Hamilton; Lord Kelvin; Michelson and Morley, who wrote on the relative motion of matter and ether; Sir Joseph Thomson; Rutherford, whose papers on the artificial transmutation of the elements appeared in 1920; and such atomic physicists as Bohr, Moseley, Chadwick, and Milliken. Among the early volumes are to be found papers by William Hershel, Count Rumford, Telford and Faraday.

The commemoration number of July, 1948, contains an historical account of the magazine by Allan Ferguson and John Ferguson, and others on eighteenth-century conditions in astronomy, physics, chemistry, mathematics, engineering and invention, scientific instruments, scientific periodicals, scientific societies, and the teaching of the physical sciences. These excellent summaries will be of interest to all readers, but the article, "Engineering and Invention in the Eighteenth Century," by Engineer-Captain Edgar C. Smith, the lively and distinguished lecturer at the Science Museum, South Kensington, will describe for the engineer the stage setting amid which the pageant of the Industrial Revolution was begun. Confined largely to Great Britain which "had become the foremost commercial nation in the world and was fast becoming a great workshop," the history of that century is no less a part of our own, for the American colonies, which gained their independence during the closing quarter of the century, had ties of family and tradition with the mother country, shared with it the rich heritage of inventiveness and mechanical skill, and provided a land area rich in resources and almost limitless in opportunities for unhampered development. Captain Smith's outline of the development of steam engineering from Thomas Newcomen (1663–1729) to James Watt (1736–1819) is an admirably condensed summary of the beginning of the steam engine. In other sections he covers iron and steel manufacture, textile and other industries, and progress in civil engineering.

Prototypes of the hundreds of scientific and technical societies that exist in every civilized nation today were to be found in Italy as early as 1560, according to the article by Douglas McKie. The Royal Society of London, founded in 1660 and chartered in 1662, was flourishing at the opening of the eighteenth century. By the end of the century academies and societies were to be found in most of the countries of Europe. In a phamphlet issued May 14, 1743, in Philadelphia, Benjamin Franklin urged the formation of a scientific society in America and offered to serve as its secretary. Shortly thereafter the American Philosophical Society was formed, while the American Academy of Arts and Sciences was founded at Boston in 1780.

Scientific periodicals appeared as a consequence of the formation of scientific societies, and in the eighteenth century as today they served the purpose of making a permanent record of the papers presented at scientific meetings and thus of disseminating knowledge throughout the world. Dr. McKie gives some interesting information about the first scientific journal, published in France in 1665, the *Journal des Sçavans* "ancestor of all its kind." The editor, Denis de Sallo (1626–1669) "was an omnivorous reader of all kinds of books and he kept two secretaries to compile notes and transcribe extracts from the books that he read. Overwork brought ill-health and enforced inactivity; and de Sallo then thought that he might incorporate such material as he was led to abstract into a weekly journal of literary and scientific news, supposing that what had interested him would likewise interest others," a not uncommon editorial policy that Ellery Sedgwick claims to have followed with the *Atlantic Monthly*. "After the appearance of the thirteenth number—the *Journal* was suppressed" because of "Jesuit irritation at disrespectful Gallican comment on a decree of the Inquisition." It resumed publication on Jan. 4, 1666, under the editorship of Abbé Gallois, was suppressed during the Revolution, and revived in 1792. It was imitated in other countries, and a discussion of it by the Royal Society of London led to a decision to publish the *Philosophical Transactions*, the official organ of that society and the first of its kind. *Transactions* was a monthly, whereas de Sallo had decided in favor of a weekly "in view of the fact that news ages quickly." It is to these periodicals that modern counterparts owe their origin.

Today the number and variety of technical publications has increased to a point where researchers in pure and applied science find it difficult, if not impossible, to keep abreast not only of significant progress in the broad field but the detailed advances in the specialties in which their personal technical interests lie. The expense of maintaining these publications and the problem of making their contents quickly and easily available are taxing the purses and ingenuity of societies and individuals. Much experimentation is under way, but the solution is not clear. It seems apparent that we face a situation which will engage our attention and ingenuity for years to come, and that the result may be types of publications and methods of reproduction and distribution quite different from what we have known in the past. The next 150 years are destined to witness great changes, and we can only hope that by means of these changes the technical man will be better served and science will be spared the confusion and waste which are beginning to hamper its orderly progress.

The EDUCATION *of* PROFESSIONAL STUDENTS *for* CITIZENSHIP

*An Approach to the Integration of General and Professional Education**

By ELLIOTT DUNLAP SMITH

PROVOST AND MAURICE FALK PROFESSOR, CARNEGIE INSTITUTE OF TECHNOLOGY PITTSBURGH, PA. MEMBER ASME

OUR complex and far-flung democracy is a democracy of men who work. Unlike the democracies of the past, it has no leisure class which is its governing class. If its imperiled freedom is to survive, its keenest and most disciplined minds—and by and large this means its professional men—must devote their moral energies and intellectual powers to becoming leaders in solving its problems.

If professional men are to assume this democratic leadership in spite of the preoccupying demands which the practice of their professions makes upon their interests and their energies, education must prepare them for citizenship more effectively than it has in the past. This cannot be accomplished merely by providing more general education of the type previously given. For as the requirement of four years of collegiate general education before entering upon professional study has become more prevalent, professional-school graduates have, if anything, become more narrowly professional and less active as leaders in the community and state.

Engineering is one of the few professions the education for which has remained consistently undergraduate. Hence whatever education for citizenship and cultivated living engineering schools have attempted to provide has been given in parallel with professional education. This has afforded those engineering schools which have earnestly wrestled with the problem an unusual opportunity to observe what in education serves to develop enduring qualities of citizenship and cultivation in professional students.

In most engineering schools, as in most liberal-arts colleges, the general courses have been taught academically by lectures, discussion, and quizzes. In our experience such academic education has tended to produce the following results: with the poorer students, a medley of miscellaneous and often ill-remembered data epitomized in the phrase, "1066 and all that;" with the better, an informed, urbane, but generally detached interest in human and social problems, and the ability and desire to discuss these problems rather than the ability and the sense of responsibility to deal effectively with them.[1]

In most engineering schools, also, general and professional courses have been taught so truly in parallel that they have never met, and there has been as little contact between them as if the general courses had been taught in college and the professional courses in graduate school. The result has usually been that the interest in professional courses has overshadowed and sapped the vitality of what the students consider "nonprofessional courses." This has tended to create a conviction that the subjects with which these courses deal are not of professional significance and do not call for the vigorous, accurate, and thorough thinking that the students learn to characterize as professional. Moreover, such interest in humanistic and social subjects as has been aroused has in large measure been washed away after graduation by the intensity of the graduate's professional "internship" and his hard struggle to get established in his profession.[2]

Most important of all, when the general courses have been taught academically and without relation to the professional, the intellectual power and discipline of mind which professional education and experience develop, have remained too strictly narrow and technical in character to be applied to the social and human problems of society. The evidence of our experience is clear that, so long as general and professional education are taught apart from one another, merely because a student has learned to think analytically, thoroughly, and unemotionally in dealing with technical problems gives no assurance that he will do so in dealing with human and social problems.

If professional students are to be prepared adequately for citizenship and cultivated living, therefore, their humanistic and social education must be given such vitality that its results will endure throughout the years of professional preoccupation that follow after graduation; it must equip them to deal with, not merely to discuss, problems of citizenship and cultivated living; and it must make their professional powers applicable to these problems. Our efforts and experience in seeking means of doing this have convinced us that it can be done and that it is worth all the difficulty that is involved.[3] What then does this experience suggest?

NO SUBSTITUTE FOR EXPERIENCE

The problems of society and of human relations are as subtle as the problems of professional practice. Handling them well calls for as much intuitive wisdom and maturity. Consequently, just as with professional problems, effective ability to deal with them can be acquired only through experience. There is no substitute for that. The lessons of human and social experience, however, just as those in professional fields, are confused, disordered, and elusive. In addition, professional men, although they cannot evade facing their professional problems, can all too easily evade facing the problems of citizenship, and thus fail to learn their lessons altogether. Hence if professional men are to learn to be effective citizens, they need preparation for learning from human and social experience fully as much as they need preparation for learning from professional experience.

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* Presented at the Inter-Professions Conference on Education for Professional Responsibility held at Buck Hill Falls, Pa., April 12–19, 1948, and constituting one of the chapters of the Proceedings of the Conference, published in book form by the Carnegie Press, Carnegie Institute of Technology, Pittsburgh 13, Pa.

[1] Paul Buck, Provost of Harvard University, in an unpublished address before the Headmasters Association in 1945 described the academic liberal education of recent years as follows: "...'liberal education' by clinging to its aristocratic precedents with no efforts to understand the actualities of democratic society became effete and to a large degree meaningless." This suggests that the results have been the same whether the general courses have been given in liberal-arts colleges or in engineering schools.

[2] Throughout the Conference there was evidence that this was also true in those professions where all general education was given in advance of professional education.

[3] For some two decades I have worked on this problem in individual courses. During the last few years, C.I.T. has attempted to integrate its humanistic and social with the scientific and technological courses into a common program which, in addition to the customary engineering objectives, aims "to assist the student to prepare himself to learn from subsequent study and experience to expand the flexibility of his professional thought, to serve society, to work well with others, and to live his own life well." Although we have learned much and have been gratified with the results attained, in some fields the work is still being conducted only in a few experimental sections, and in none is the program so fully established as no longer to be considered experimental.

The problem of preparing students to learn the difficult and costly lessons which experience alone can provide, and equipping them to put this knowledge to use in dealing with problems is the same in the human and social as in professional fields. In either field students will get little preparation for dealing with experience if the primary mental exercise which education provides consists in reading, in listening to expositions, and in written and spoken discussion. In both fields, what is essential is that from the start, before bad habits are formed, students do the same things in college which as cultivated professional men and citizens they should later do among the confused, disorderly, and difficult conditions of the real world, namely, deal with concrete situations and learn from doing so. For in college, in contrast with experience after graduation, the lessons of experience can be ordered and moderated to meet educational needs, the student can be guided by instruction, and the cost of error is sufficiently low so that the student can take the risks inherent in effective learning.

EXERCISE ART OF USING KNOWLEDGE

To get full value from learning from such controlled experience, its lessons must provide both systematic growth in fundamental knowledge and repeated exercise in the art of utilizing it. This exercise should be of two sorts. On the one hand, by essentially the same procedures that have made the case method so outstandingly successful in the teaching of law, the student should be given exercise in the art of extending and deepening his human and social knowledge by careful inductions from concrete incidents. On the other hand, by essentially the same procedures that have made the clinical method so outstandingly successful in medicine, he should be given opportunity after opportunity to strengthen his fundamental knowledge and to learn how to use it by putting it to use in the well-ordered treatment of concrete problems.

All that has been said at the present Conference about the use and value of such methods of instruction in professional courses applies to humanistic and social courses. There is the same importance of distinguishing "learning instances" from "professional problems," and of using "instances" as the primary means of extending knowledge by inductive inference. There is the same danger of cheating the student of the opportunity for independent learning and problem solving by substituting teacher-made illustrations for "instances," or subprofessional exercises for true "problems." There is the same need for adjusting the level and complexity of both "instances" and "problems" to the needs of the students. There is, in addition, even greater danger from the substitution, in class or in written reports, of debates or discussions for the ordered discipline of inductive learning and of problem solving, and thereby producing a facility in talking plausibly about public questions which will make it difficult thereafter for the student to do the harder work of discovering what the true problem to be dealt with is, and devising and executing a sound plan for its treatment.[4]

There are, of course, great difficulties to be overcome in applying successfully the methods of professional education in humanistic and social fields; but in our experience these difficulties are no more insurmountable in history, English, psychology, or economics, than they are in medicine, law, or engineering. It is also our experience that when professional students are taught the humanistic, social, and basic science subjects which constitute general education in this way, the increase in power and in zest for learning is in some measure comparable to that which characterized the shift from the textbook learning of law and medicine to the case and clinical methods.

CONTENT OF HUMANISTIC SOCIAL EDUCATION

The problem of securing vitality and usefulness in humanistic and social education, however, is not only one of method It is equally one of content. The problem of content, moreover, is not primarily curricular. Although it is, of course, essential to provide a curriculum that has cultural and social balance, any mere curricular reconstruction will leave major problems of content untouched. For in education which aims to develop the power to utilize knowledge, the most fundamental questions of content do not relate to curriculum but to the character of what is taught within the curricular areas.

In general as in professional education it is clearly impossible to teach the student all that he needs to know. In general as in professional education it is harmful to attempt to teach the student all the data and technique we can. Attempting maximum coverage is as likely to result in shallowness in the one as in the other. Attempting coverage in general education is even more likely to prevent learning from being sufficiently thorough to equip the student to use what he has learned throughout his life than it is in professional education where inadequate initial learning is strengthened by extensive further instruction. Cramming the student with particularized humanistic and social knowledge is as likely to load him with information, much of which will be out of date at the time of use, as cramming him with particularized technical knowledge.

The impossibility of teaching the student all that he needs to know and the harm of seeking to teach him all that we can arise under all methods of instruction; but they are greatly amplified if we employ the slow methods of case and problem teaching. This raises the question of whether it is wise to use the methods of professional education in humanistic and social education at all. The answer of our experience to this question is clear. These methods can be used provided the question of content is properly handled. When they are so used, they are of great value.

CONTENT AND METHOD INTERRELATED

In the humanistic and social as well as in the professional fields, what is important for the student to possess on graduation is not immediate knowledge but the ability to acquire the knowledge that he needs at the time when he needs it. If the student has acquired in college appropriate basic knowledge and a mind trained in its use, particular knowledge can with reasonable facility be acquired after graduation at the time of need. The converse, however, is not true. In fact a mind with a slender equipment of basic understanding is put under a distinct disadvantage in using the few fundamental concepts which it has, if these are overlaid with a heavy deposit of inert particulars. If, therefore, the student is taught the art of using fundamental knowledge to acquire particular knowledge, the area of immediate knowledge that he must learn in order to gain adequate range of potential knowledge is so reduced that there is time available to teach the necessary knowledge and to teach as well the art of utilizing it in learning, working, and living.

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[4] This is given special treatment in a paper, "The Use of Problems and Instances," by Prof. R. Teare, in the book "Education for Professional Responsibility," Carnegie Press, 1948.

Content and method are thus inextricably interrelated. They are the two inseparable lobes which constitute the heart of education.[5] On the one hand in order to have time to teach students to use knowledge, we must focus content on those fundamentals which are useful in later learning. On the other hand in order to be able thus to focus content on fundamentals, and not have to teach students masses of particularized knowledge, we must teach these fundamentals by methods that equip the student to use them to continue to learn, and thus equip him with abundant potential knowledge.

It is usually difficult to get academic faculty members to recognize this and, letting go of the customary, to determine their course content by the answer to the searching question of whether what they are teaching is truly basic to later learning. For somehow members of academic, even more than of professional faculties, find it hard to believe that students can, if properly taught, continue to learn as a result of their instruction. Consequently, they are likely to lack the courage and vision to abandon the attempt to stuff their students as full as possible of information and techniques in the all too short time that they have them at their ample boards.

This question of coverage is a critical one. In our experience, schools and courses, whether general or professional, can in large measure be divided into those which develop the students' mental stature and those which cramp their minds, on the single basis of whether the education they provide is focused upon the mastery of fundamental content useful in learning throughout life or upon purveying the maximum of immediate knowledge.

In the social and humanistic fields, there is still another problem of content to be dealt with. In the older professions, years of careful thinking by practitioners and scholars have developed out of the basic sciences a well-ordered structure of useful fundamental knowledge formulated in terms adapted to professional use. General education has lacked this adaptation. The development and formulation of its knowledge has been primarily related to the specialized research of advanced scholars, and all too much of it consists of "the lifeless residue of obligatory doctoral dissertations." Consequently, much even of the basic humanistic and social knowledge needs restatement to make it useful to the professional man and citizen in extending understanding or in problem-solving. This is much more true of some fields than others, but is in some measure true of all. In our experience it has invariably been illuminating and rewarding, before teaching any humanistic or social course, to prepare a careful compact statement of the fundamental principles or concepts to be taught in the course in the form most useful to students as a basis for further learning and for problem-solving.

To make humanistic and social courses education in the art of acquiring and utilizing knowledge, valuable though this is, cannot in itself solve the problem of preparing professional students for citizenship and cultivated living. For professional study and work is so preoccupying that unless the ability to deal with human and social problems is grafted into the strong tree of professional growth, the effects of humanistic and social courses, no matter how taught, will be likely either to wither from lack of nourishment or become a mere decorative mistletoe. Only if general education is so united with professional education that it teaches students to apply their professional aptitude and skill to handling human and social problems, will professional graduates be equipped to do their share in meeting the problems of society.

THE UNITY OF SCHOLARLY AND PROFESSIONAL THOUGHT

Careful studies of the methods of thought in the fields of law, medicine, engineering, business, physical science, social science, and the humanities have convinced us that regardless of field—academic or professional—there is a fundamental unity in all scholarly and professional thought, whether applied to the extension of knowledge or the treatment of concrete problems. Consequently, when both the technical and the general courses are properly taught through ordered exercise of the arts of inductive learning and of problem-solving, it takes little more than explicit recognition of this underlying unity to unite them through the part which they play in the joint development of a common scholarly-professional method of extending knowledge and handling problems.[6]

To bring students to recognize this unity of professional and scholarly thought involves having instructors with sufficient generosity of mind to work out together and use in their courses common formulations of the common fundamentals of well-ordered extension of knowledge and problem-solving. For without common formulation it is difficult for students to grasp and exercise the underlying unity of thinking which should bind their courses together. But when, with the aid of such formulation, general as well as technical courses are taught as applications of basically common ways of thought, work in each field—technical, social, or humanistic—adds its individual contribution to the common professional and scholarly stature which all courses assist in developing.

For example, to deal with historical problems following the common professional-scholarly method gives exercise in weighing evidence and in the process of sifting out of a confused mass of events the issues which constitute the fundamental problems to be dealt with. It thus teaches the student important aspects of the general art of problem-solving difficult to teach as well in other fields. Moreover, it makes the student aware of the several sectors which constitute the full circle of understanding of any problem, social or professional. When a student so taught in history, later approaches a problem from the angle of law, medicine, economics, or engineering, his work in history will help him both to discover what the true problem is and to recognize that to look at it solely from the angle of one field, in spite of the apparent clarity which results, does not constitute realism, but a half realism as unreliable and deceptive as any other half-truth. Likewise, economics and psychology, if taught in relation to the underlying unity of scholarly and professional thought, give the student unusual opportunities to learn for all his work thereafter both how to simplify a problem so as to be able to utilize special analytical tools in dealing with it and how to accompany this simplification with sufficiently sound planning so that later rectification will restore full realism.

The very emphasis upon unity of thought thus prevents the development of any stereotyped general method or of an elaborate battery of particularized routines for dealing with special types of subjects or problems. The common basic methods of using fundamental knowledge to extend understanding or to deal with problems, on being applied in widely divergent fields, on the one hand become flexible and capable of adaptation by the student to the exigencies of particular situations, and on the other hand, become so fully assimilated by the student that they cease to be methods which he follows but a style which is his own and which like all good style expresses his individuality.[7] Moreover, since the way of learning or of problem-solving which the student acquires is the same in all fields, professional skill is freed from professional boundaries and made available for human and social problems. Since the method is common, whatever in college or in later life develops it in one field will develop it for all.

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[5] See "The Lopsided Harvard Report on General Education," by W. T. Fisher, *Journal of General Education*, vol. 1, no. 3, April, 1947, pp. 195–199, for a profound and provocative discussion of the whole problem of the application of fundamental educational methods as developed in professional education to the content and purposes of "general education."

[6] President Rogers, in his paper, "The Education of the Engineer—Gaps Between the Statement and Achievement of Objectives," published on pages 895–897 of the November, 1948, issue of MECHANICAL ENGINEERING, points out that the greatest gap in engineering education lies in the lack of a generic philosophy of engineering thought and a consequent failure 'to integrate courses and to develop a general power of constructive thought.

INTERRELATING TECHNICAL AND SOCIAL EDUCATION IN CONTENT

To extend the interrelation of general and professional education beyond method to content is also important. The interrelation in content is both real and fundamental. For in spite of the prevalent technical isolationism of most professional teaching, every practitioner of professional stature knows that human and social problems are inherent in all major professional problems and must be dealt with if such problems are to be handled on a professional level. When, and only when, problems are thus fully dealt with is the student in facing a problem forced to ask the truly professional question, "What, all things considered, should be done?" Otherwise, he is confined to the technical half question, "How can I do my stuff?" the answer to which is a dangerous half truth. Moreover, only when he asks and answers for himself the full question of what should be done can a professional man accept moral responsibility for his own professional conduct and determine for himself what values his technical competence will serve instead of leaving this to be determined by others. The very process of teaching the professional subjects so that the student deals fully with professional problems thus makes the content of human and social education part of the content of professional education.

To deal with professional problems on all sides so as to interrelate the technical with the human and social, is not easy. It is especially difficult in the early years, when in order not to confuse the student, the problems used in learning must be kept sufficiently simple so that with little experience to guide him he can understand and handle them adequately. Moreover, it is difficult to get any but exceptionally mature students to deal with all sides of a problem at any time. It is also difficult for an instructor, who attempts to have his students deal with all sides of a problem, not to carry his students cursorily through its social and human areas and thus subordinate these areas to the technical ones where both he and his students have confidence in the importance of the questions they are dealing with and in their ability to handle them.

In spite of these difficulties the path to follow is clear; and in seminars or otherwise, as students advance they can genuinely and effectively be given such total problems to deal with and by carrying the investigation of these problems out to all their branches integrate the social, human, and technical aspects of professional education. When this is done in the upper-class years, the coming events cast their shadow before, and even for the beginning students the fact that what they are learning in their humanistic and social study will be used in their advanced professional work, adds professional zest. Unless this is done and students learn to discover and deal with the human and social aspects of their professional problems under the favorable conditions of college instruction, they will be ill-equipped to deal with them or even discover them amid the hurried and confusing conditions of professional practice.

The fact that humanistic and social education in this way can be made part of professional education raises the question of why there should be any separate humanistic and social courses at all. The answer is similar to that to the question, "Why should engineering students who are to have extensive training in the technological applications of the science study basic science at all?" Without prior discipline in basic science, education in applied science can never be raised to the truly professional level of teaching the student the art of utilizing well-ordered fundamental knowledge. Without basic training in the principles and disciplines of the underlying humanistic and social-science fields, the attempt in the concluding period of professional education to touch on the human and social aspects of professional problems can develop only amateurism or practical cunning—not well-ordered professional power.

Moreover, unless the humanistic and social studies themselves are related to the student's profession at the time they are taught, the student is likely to look upon dealing with human and social problems solely in relation to his professional work. Then, regardless of how broad his professional instruction may be, he is likely in later life to fail to see his responsibility to utilize his professional powers in dealing with the problems of citizenship or of living his own life well. Merely that a student has been taught to deal broadly, humanly, and socially with his professional problems does not insure that he will have the interest or ability to turn from his professional preoccupations to deal with the problems of citizenship.[8]

Moreover, unless a professional student while in college takes time apart from his professional studies to cultivate his mind and spirit and to study the problems of the society in which he will practice his profession, he will form habits of letting the professional preoccupy him to the exclusion of the cultural and the civic—habits which it will be difficult to overcome in the later crowded hours of professional life.

To be prepared for citizenship, he must be taught to recognize and deal with the problems of citizenship as such and to take time away from his professional work in order to do so. In no other way will the lack of professional leadership in our social structure be remedied.

INTEGRITY OF HUMANISTIC-SOCIAL DISCIPLINES MUST BE MAINTAINED

Important as it is to teach humanistic and social subjects in relation to the student's profession, there are serious dangers involved. For, once one permits professional interest to enter into an academic course taught in a professional school, it is easy to let the professional become central and to fail to maintain the integrity of the humanistic or social discipline. Then the primary contribution of humanistic and social study both to professional education and to education for citizenship, as well as to the cultivation of the student's mind and spirit. is lost. Much experiment has convinced us that history, for instance, must be taught as history, economics as economics, if

(*Continued on page 982*)

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[7] The extent to which, even within the confines of strictly legal instruction, basic skills "appear to flow . . . from a period of exposure to 'the' method in different varieties" is discussed by a committee of the Columbia Law School in a report entitled "The Place of Skills in Legal Education," published in the *Columbia Law Review*, 1945.

[8] The evidence cited during the Conference as to the extent to which an experimental group of medical-school graduates, in spite of the broadening of their clinical training to include the human and social aspects of their medical problems, were confused, reluctant, and even rebellious when faced with social problems which took them outside of the customary clinical relationships, points to the extent to which this is true even in regard to problems close to the student's professional field.

ENGINEERING *in an* ERA *of* BIG SCIENCE *and* BIG BUSINESS

By WILSON COMPTON

PRESIDENT, THE STATE COLLEGE OF WASHINGTON, PULLMAN, WASH.

DO you want your grandchildren to be dependent—and I mean literally dependent—for their livelihood on big industry, big management, big labor, big agriculture, big science, or big government? That is the direction in which we are now moving. If that is what we want we need perhaps do nothing about it since we are well on the way. If, however, we are at least doubtful about it, we may stop, and look, and listen.

We all know the familiar statistics of bigness. Most of our leading industrial enterprises and labor and Government were big before the war. The war merely made them bigger. We have learned that big industry is indispensable to mechanized war. Had it not been for big industry in America, probably we would now be discussing the past and not the future of engineering.

BIG INDUSTRY

What is big industry? It is easier to illustrate than to define. Big industry is something more than merely bigger than small industry. Big industry now has come to include big management: General Motors; General Electric; General Foods; American Telephone and Telegraph; U. S. Steel; Aluminum Corporation of America; Radio Corporation of America! These names among others readily occur to one as exemplifying big industry. They are among the most reputable names in American life. They do not control but they dominate. They have their own research laboratories. They make people dissatisfied with what they have. Then they undertake to satisfy the new wants so created. That is exactly what they are expected to do.

The so-called "managerial revolution" during the last 40 years has largely transformed American industrial and commercial enterprise. Few of our big industries are now "controlled" by the people who "own" them. Most are controlled by the people who manage them. Owners can control but ordinarily do not. It is said of many corporations that control of as little as one tenth of its stock practically means control of the corporation; and it is obvious that a management once established in a big enterprise has to be pretty "bad" before the "owners" change it.

In an industry "dominated" by some large enterprise what nowadays happens to a "little" man with a "big" idea, unless he happens to be employed by a "dominant" enterprise? Can he form a company to develop the idea and can such a company be financed? Sometimes yes; often no; and the latter result is becoming more frequent. He of course can "sell" his idea if it is a good one to a company already established; and he often does. But it then involves not merely the merit of the idea itself but its effects on the total affairs of the company, including its corporate political affairs; and these have become more influential and in some instances even decisive since the "managerial revolution" has so sharply differentiated management from ownership.

BIG LABOR

Big labor is another by-product of big industry. Some say the reverse is the fact, and in some industries it is. But in general big unionism has followed rather than preceded big industry.

Big unionism is a big subject. If I were an industrial employee and were eligible to join a reputable union, I would do so. Many of the results of big unionism are on the assets side of the ledger. Some are equally on the liabilities side. Still others are in the twilight zone of honest debate and disagreement. At least one thing is certain: Big unionism has added to the difficulty of finding employment on the part of the person who prefers not to join a union; and in many industries it has added to the complexities of starting a new enterprise.

Forty years ago, I was working on a large construction job in a small Ohio town. I was a "mud-boy" and my job was to keep supplied with mortar a brick mason to whom I was assigned. His name was Mr. Winters. He was a craftsman and proud of his craft. He worked ten hours a day and so did I. He got 30 cents an hour; I got 16 cents. He set his quota of brick at 1200 a day in place, and he met his quota. He also made my quota in mortar, and I met that too. There were no elevators on the job in those days; the mud-boy simply climbed a ladder with a hod on his shoulder.

A month ago I asked the contractor on one of the large buildings under construction at Washington State why it was taking so long to get the brickwork finished. He replied: "Do you know what we are paying to get bricklayers on that job?" I said I did not. "Thirty-two dollars and fifty cents a day," he replied. "And how many brick a day are you getting in place?" I asked. "Oh, we're doing pretty well, about 400 in nine hours," he said; and his son interrupted him to say: "Father, we're not doing quite as well as you think."

This, although it is not a fable, does at least have a moral. These phenomenal wage rates do of course tend to price brick-masonry construction "out of the market." But this is one of the expectable results when there are more jobs than there are masons. I doubt that many would begrudge the mason his high daily pay; but few persons would seek to justify his deliberately reduced production. Even the brick masons themselves do not justify it except on the ground that "others do it too"—which to say the least is a demoralizing line of reasoning.

This growing practice of laying brick by the "conference method" is gradually putting a blight on brick construction in the Northwest and elsewhere. Big labor, if it has not aided and abetted the practice, at least has done nothing in earnest to discourage it. The only present recourse is to avoid brick construction. That is difficult and it should not be necessary.

Again, a great industry caught in the inexorable squeeze between supply and demand is gradually pricing its products beyond the reach of ordinary builders. Meantime as a stimulus to small housing the Federal Government, by act of Congress, on which the ink is scarcely dry, is guaranteeing mortgages to the extent of 95 per cent of appraised value on owner-built and

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owner-occupied small homes, and 90 per cent on similar small homes built for rental. The financial stilts supporting our economy are becoming higher and higher, and the distance from the ground greater and greater.

BIG AGRICULTURE

With living costs continuing to mount, an increasing percentage of people, estimated recently by the President's Council of Economic Advisors at about one third, is currently living beyond its current income. The public pressures for reduction in food prices have become urgent. In the last regular session of Congress an effort was undertaken to secure the enactment of legislation supporting farm prices on a basis somewhat lower than the 90 per cent of parity provided under present law. Agriculture has never thrived on "boom or bust." Such legislation would be in the long-time interest of agriculture; and it might moderate present food prices somewhat. Undoubtedly, it would result in lower prices for some farm commodities during the next year. The major farm organizations were unable to assure support of such salutary legislation because of opposition at the "grass roots" to tampering with the present "comfortable" prices. So big agriculture, like big industry and big labor, if not aiding and abetting present inflation, is at least doing little to avert or retard it.

BIG GOVERNMENT

The point at which government in the United States began to be big Government in the sense of major economic as distinguished from political determinations is debatable. At least it is debated. I suspect that it began with the first protective tariff act designed to foster infant industry. Probably the initial gestures toward central banking a century and a quarter ago and the first federal income tax more than eighty years ago were the next steps toward big Government. These were short-lived. Big Government in the modern sense in this country had its roots in the Income Tax Amendment to the Constitution approved during the Wilson administration. While that proposed amendment was pending, I recall having listened to the late Nicholas Murray Butler, then president of Columbia University, in a speech in 1912 or 1913 opposing the amendment, say: "If this amendment is adopted, it will eventually change our form of government; it will put the entire income of the American people at the disposal of Congress and will enable the many to spend the money of the few."

In the Hoover Administration the Federal Farm Board and the Reconstruction Finance Corporation established in principle a limited responsibility of the Federal Government for national economic programs and for financing relief in emergency. But the borrowing, spending, and lending policies of the Roosevelt administration and the various extensions of federal regulation of economic factors have been the principal sources of the pattern of big Government as we know it today.

RIGHT TO CHOOSE OR CHANCE TO CHOOSE

I am speaking of these developments not critically but historically. Whether they have been good or bad, constructive or destructive, wholesome or unwholesome, time will tell. History may not be written in advance, and no one is smart enough to visualize the ultimate consequences of the changes in the pattern of American life which have occurred during the past forty years and are still under way. Yet a few facts stand out; and some of them at least are important:

1 We have as yet found no adequate substitute for "cheap land" which during the era of westward expansion provided the nation's greatest reservoir of "free enterprise."

2 The most promising "new frontiers" are in new industries and in various reclamation and irrigation projects.

3 Present conditions do not encourage new industries or at least new enterprises.

4 Gradually, as a people, we have been losing individual liberty. We still have the "right" to choose. But gradually we are restricting the "chance" to choose.

A few weeks ago in reading some interesting documents of American history, I came across a letter from Thomas Jefferson to President Willard of Harvard University. It was dated March 24, 1789. This is what he wrote:

"What a field have we at our doors to signalize ourselves in! The botany of America is far from exhausted, its mineralogy is untouched, and its natural history or zoology totally mistaken or misrepresented. It is the work to which the young men whom you are forming should lay their hands. We have spent the prime of our lives procuring them the precious blessing of liberty. Let them spend theirs in showing that it is the great parent of science and of virtue, and that a nation will be great in both always in proportion as it is free."

Jefferson was one of America's first great engineers. You may say that engineering has made great advances since his time. But Jefferson was a statesman even more than an engineer. You may say that political science too has made advances since his time. But I doubt that any informed person would challenge the wisdom of his charge to the students of Harvard University over a century and a half ago any more than he would challenge the soundness of the political principle in the Declaration of Independence, the foundation of our "free society."

Least of all would engineers challenge it, because a "free society" has been the foundation of its great professional achievement. Herbert Hoover after a span of one hundred and forty years was Jefferson's successor as a great engineer-president. Those of you who worked with Mr. Hoover during the first world war or during the decade of the twenties or who have read his "American Individualism," or his later "The Challenge to Liberty," will know the extent to which he in our time has followed the same path as Jefferson as he charged the students of Harvard University "that individual liberty is the great parent of science and of virtue, and that a nation will be great in both always in proportion as it is free."

No man in this generation has given greater distinctions to the profession of engineering than has Mr. Hoover, not only in America but throughout the world. No man has set a finer example to his countrymen of fidelity to public trust in great affairs both at home and abroad; and you, among his fellows in the engineering professions, share with those of us who were privileged to work with him in the public services of two decades ago, a great satisfaction in the phenomenal rise in public respect, esteem, and affection for the nation's only living ex-President which has occurred in recent years among men of all shades of political belief.

PACIFIC NORTHWEST THE LAST "NATURAL" FRONTIER

The Pacific Northwest is an area of great natural resources in soils, forests, minerals, and climate. But its most distinctive economic characteristic is its low-cost power. The total generation of hydroelectric power in the United States is a little over 10 million kilowatts. Of this $3^1/_2$ million kilowatts, or 35 per cent, last year was in the Pacific Northwest. Estimates of the eventual power capacity of the Columbia River system range from 20 million to 26 million kilowatts, depending in part on the information and in part on the enthusiasms of the estimator. The Army Corps of Engineers and the Bureau of Reclamation in co-operation with the other members of the Federal Inter-Agency Commission have studied in recent years over 1000 possible dam sites on these rivers; and in the Commission's forthcoming report will identify dams with power potentials of over 16 million kilowatts. Of these, Congress has already authorized dams which when completed will provide over 3 million additional kilowatts. The estimated total cost is $900,000,000. The Corps of Engineers is proposing additional dams with a total power capacity of $5^1/_2$ million kilowatts at an estimated cost of $2,000,000,000 to be completed by 1962.

These proposed developments are in part for flood control, in part for navigation, in part for reclamation of irrigable lands. All have a power potential, and the whole is estimated to be self-liquidating, including interest on investment at the statutory rates, within a reasonable period of time at rates about 20 per cent higher than the present rates based on installations at lower costs already made at Bonneville and Grand Coulee. No one may successfully impeach the evidence that these power dams will pay their own way and in so doing pay for the reclamation of millions of acres of fertile land. But there are more potent reasons than this for diversified river development in the Pacific Northwest.

TRANSPACIFIC RELATIONS

Since Colonial days America has looked across the Atlantic, and its transatlantic relations have in large measure determined its place in the world of today. But in the century ahead our transpacific relations will be as important to us as our transatlantic relations, eventually perhaps more important. A strong China and a peace-keeping Japan may mean as much to us as a stable Europe. China, although she has developed the habit of civil strife at home, has at least the wholesome tradition of peace abroad. A strong China eventually will emerge, and a strong China in the center of a billion of population in the Orient is important to the security of the United States. It may be indispensable.

Peace in the Pacific will depend on trade in the Pacific. If trade does not cross national boundaries, armies will. That is one of the severe lessons of history. Trade in the Pacific depends on the development of the Pacific Coast—and not merely in California. Commercial rivalries among the Pacific states have of course some comic aspects. But they have also some stern and wholesome realities. No one nowadays thinks of future transpacific relations without including the Pacific Northwest as a vital, if not a determining factor; and the building of the Northwest depends upon the building of hydroelectric power.

These and all their implications in terms of diversified industry mean much to the mechanical engineer. I need not relate the Northwest potentials in the processing of forest and agricultural products and their chemical and mechanical derivatives; or in minerals, clays, and light metals; or in chemicals. I am a newcomer to the Pacific Northwest, and I have been astonished at the extent and diversity of its resources. You too have been interested and impressed by the population trends during the past seven years showing an increase of 40 per cent in California, 36 per cent in Oregon, and 34 per cent in Washington.

The Pacific Northwest today is faced with a power shortage, an acute and growing shortage. Industries wishing to establish themselves in the fast-growing Pacific Northwest are unable to do so because of the scarcity of firm power. The regional power requirement is estimated at $10^1/_2$ million kilowatts by 1962. This requirement can be met. If it is met, the Pacific Northwest will be another diversified agricultural and industrial frontier available for development for many years to come.

But if it is true that present conditions do not encourage new enterprise, what can be done to improve these conditions? Obviously, the continuing kaleidoscopic balance between peace and war retards new enterprise or at least long-time investment in new enterprise. Bolder souls than mine are tackling that fundamental problem, and on the outcome of their endeavors depends the success of almost anything else which we may do. But it may be that we shall have to live for a long time with the threat of war hanging over us as a "Sword of Damocles." If so, we shall have to organize our life as did Nehemiah when he rebuilt the walls of Jerusalem with a stone mason at every ten paces to build, and a man with a spear at every twenty paces to protect the builder; or as our Pilgrim fathers did when they went to their fields with a hoe on one shoulder and a musket on the other.

TAXING, LENDING, AND SPENDING

But there are other steps within our own reach which we may take if we have the courage to take them, which will soundly strengthen our national economy and may give such impetus to new enterprise as will reinforce our free society by giving more of a chance and a wider range of choice to individual enterprise. I have spoken of the Federal income tax, coupled with the growing national policy of lending and spending, as the principal source of what we now familiarly know as big Government. The income tax has enabled us to finance two big wars, the "arsenal of democracy," and a gigantic national debt. Also it is one of the greatest barriers to new enterprise without which we will not pay our debt and, in the process, will lose more of what Jefferson called the "precious blessing of liberty."

Governments as well as households, over a reasonable period of time, must live within their income. That is not a political statement, or if it is, it is a statement made emphatically by the heads of both political parties within recent years. Also it happens to be a fact—one of the most important facts with which the American people have to deal. To be sure, many of us for many years have been trying, in both public and private affairs, to find some substitute for paying debts, or at least some way of postponing payment until some more convenient "tomorrow." To this end great ingenuity has been shown. Some of the arguments have been so alluring, so ingenious, and so convincing that a considerable group of our people have at least momentarily persuaded themselves that it makes no difference how much we owe as a nation as long, so they say, as we owe it to ourselves.

The plain fact is that the only reason that we have been able to borrow the huge amounts which have financed the arsenal of democracy, has been the fact of huge national savings. These savings in turn are a result of great national production. The minute we as a nation conclude that it makes no difference when or whether we pay our debts, we start down the road toward the destruction of savings, the destruction of investment, and the retardation of new production and new enterprise. It may take a long time to get there; it may take decades and perhaps generations. But we will be on the way.

None of us will deny that as a nation we have not been coming to grips with the combined economic consequences of a prolonged depression and a long war. We have been putting off the day of reckoning. We are still putting it off. We owe a heavy debt representing our investment in war; we are now making a great investment in peace or at least in the hope of peace; and yet we talk about a "general" reduction in taxes. In fact we have already had a moderate general reduction in taxes at a time when most of us should have been paying more taxes not less, and at a time when Congress, with our encouragement, should have been making a forthright start on a systematic payment of our national debt instead, for the most part, of a few bookkeeping entries.

No, that also is not a political statement. Nor is it socialistic, except to the extent that all income taxation is "socialistic," which essentially it is. That is a simple statement in behalf of the only kind of national policy which in the long run will preserve the kind of "free society" and the kind of "free enterprise" of which we so freely boast.

TAXATION CHOICES

The cynics say that the only lesson that we learn from history is that we do not learn from history. Engineers are not cynical. Otherwise they would not be engineers. Big Government, big industry, big labor, big agriculture, even big science—none of them want to give up what they regard as their "gains." I am not advocating that they give up any gain. I am merely pointing out that these so-called gains are illusory and will be transitory unless they are coupled with (1) a forthright plan for the orderly payment of the national debt, as an indispensable means of fortifying the whole structure of national finance; and (2) a national system of income taxation which will enable the Government to pay its debts and pay its way without permanently retarding new production, new industry, and new enterprise. If this means continuing heavy income taxation, at least it has the lessons of history behind it. Temporarily we may resort to inflation as a means of moderating the most urgent pressures. But deliberate inflation is merely a form of regressive taxation and the equivalent of partial repudiation. Inflation is "comfortable" for a while; it postpones the "day of reckoning;" and it makes the day of reckoning more severe when it comes. This too has behind it the stern lessons of history.

How would you like to be a member of Congress confronted by a dilemma of this kind in an election year, or for that matter, in any year? If Congress tries to make us too comfortable, it will only be making our grandchildren too uncomfortable; and if Congress makes us too uncomfortable, there may be no grandchildren. If you have followed the Congressional Committee hearings and debates during the past two years, you will know that almost every variation of taxation policy has potent and ardent supporters. Some advocate a policy of low taxes on everybody; others a policy of high taxes on everybody; and still others a policy of higher tax rates on some classifications of taxpayers and lower tax rates on other classifications.

The first—low taxes on everybody—eventually would mean that we would not pay our debts but would pass them on to our grandchildren; and would irreparably weaken the structure of our national finance. The second—high taxes on everybody—eventually would so retard new production, perhaps stifle new enterprise, that we would not be able to pay our debts and pay our way even at high tax rates; and would undermine free enterprise in any sense worthy of the name. The third I think is the way most likely in the long run to do the most good and the least damage.

TO ENCOURAGE PRODUCTION

For example, I should think that, in the case of new corporations, for a period of years the exemption from taxation might be increased; and that the first $50,000 or perhaps even $100,000 of taxable income might be taxed at a much lower rate than is applicable to corporations generally. The same principle might apply to individual or partnership income derived from new industries, new enterprises, or new sources of production. Perhaps administratively it would be necessary to apply this alike to all corporations, individuals, and partnerships deriving income from production; but it should be limited to income "from production."

Obviously, such a tax policy would discriminate in favor of small enterprises or enterprises of moderate size; and would discriminate in favor of new industry, new production, and new enterprise. It would at once raise the issue whether big industry, big agriculture or "big" any other form of enterprise in production is to be penalized merely because it is big or at least because it has taxable income beyond the exemptions and low rate brackets. This is a serious issue.

It seems to me that the answer to this question depends on the objective at which we are aiming. If the objective is to avoid discriminatory taxes, then the case for such a tax policy is correspondingly weak. In that case, we should, however, review the entire system of Federal income taxation including its rate schedules which are full of discriminations based on income classifications and differentials; also no tax is likely to be more "discriminatory" than the present mounting inflation. But if the objective is to stimulate new enterprise, the case is correspondingly stronger. In my judgment the national interest is greater in stimulating new enterprise than in avoiding further tax discriminations if such discriminations are necessary to induce and encourage new enterprise.

Again, I am relying on the lessons of history when I say that it is in the interest alike of big industry and little industry, big agriculture and little agriculture, big labor and little labor, that we follow a course which will enable us to pay our debts, pay our way, increase production, enlarge the field of enterprise, and stimulate science by rewarding inventiveness; and that this will not be accomplished without some substantial income tax consideration. Taxation is the most sensitive nerve of our national economy. In a "free economy," there is no such thing as a completely equitable system of income taxation.

I am not trying to write a book. I am merely ventilating an idea which should be ventilated. There may be more practical suggestions than those which I have made. But they will not be more practical unless they better serve the objectives which I have mentioned.

Engineering, especially mechanical engineering, is a crucial factor in the progress of industrial and agricultural production. These problems are not likely to be solved without your help. Unless they are solved another generation of engineers is likely to find that its future is in the past.

THE rapid measurement and recording of heat exchange between the human body and its environment is being studied by the Research Laboratory of the American Society of Heating and Ventilating Engineers, ASHVE President, Prof. G. L. Tuve, announced recently. Professor Tuve is a member of ASME. This study is being sponsored by the Naval Medical Research Institute and the Office of Naval Research.

The initial investigation is concerned with the possibility of designing, developing, and constructing a calorimeter capable of holding a human subject. In addition to measuring the heat exchange of the body with its surroundings, the calorimeter must be capable of creating sudden changes in environment. Thus, observations of the heat exchange of the human body under a variety of experimental conditions can be made.

Previous research has established the mechanics by which the temperature control system of the body maintains approximately constant internal temperatures over a wide range of environmental conditions. However, little is known about the effect of environment on the heat generated within the body. It is hoped that these studies will add materially to our understanding of the effect of environment on human metabolism.

Almost from its inception in 1919, the ASHVE Research Laboratory, in co-operation with medical authorities, has been investigating the effect of atmospheric environment on human beings and their sense of comfort. Since 1946 the Medical School of the University of Illinois has been conducting research sponsored by ASHVE on the so-called "shock effect" encountered when entering or leaving a summer air-conditioned space. The results of all these studies have contributed greatly to human comfort and health.

Developments in BURNING PULVERIZED COAL

Thirty-Year Review of Experience in Milwaukee Plants

By F. L. DORNBROOK

WISCONSIN ELECTRIC POWER COMPANY, MILWAUKEE, WIS. MEMBER ASME

GENERAL

THE Wisconsin Electric Power Company, formerly known as The Milwaukee Electric Railway and Light Company, was the first power utility to adopt the process of burning pulverized coal under stationary boilers. The process now has been adopted almost universally by power utilities and by many other industries.

At the time of the first world war, in 1917, coal was burned in the Milwaukee power plants on underfeed stokers, and boiler units were of the order of 468 to 810 bhp. Efficiencies were average for that day, outages were frequent and accepted, and the quality of coal was becoming worse while the cost of coal was becoming higher.

Coal had been burned in a pulverized form for about 25 years previously in the manufacture of cement. Pulverized coal also had been used in annealing and forging furnaces, and in the manufacture of refractories. Some work had been done to apply it to locomotives, but no one had appreciated the economies and advantages of applying pulverized coal to stationary power boilers.

ONEIDA STREET POWER PLANT

When faced with higher coal costs and a question of what kind of stoker should be selected to burn every kind of coal, it was thought that better results could be obtained if all coal were burned in a pulverized form. That was the birth of a trial installation in the Oneida Street power plant in Milwaukee, early in 1918, on one boiler and shortly afterward on four more boilers, Fig. 1. New stokers which were on order for five 468-bhp 160-psi boilers were redesigned and transferred to other boilers, and the five 468-bhp boilers were equipped with furnaces and burners for firing pulverized coal. The management of the company felt it was desirable and decided to have a supply of pulverized coal in storage above the boilers rather than to burn the coal as it was milled. Such problems as drying coal, conveying coal, condensation of moisture in bins and furnace slagging had not yet become nightmares to disturb the pleasant dreams of the bold pioneers.

By November, 1919, it was possible to perform tests on the five 468-bhp boilers burning a mixture of pulverized screenings. A test of 99-hr duration, or a total of 495 boiler-hours, showed a gross efficiency of 80.67 per cent. Mr. Paul Thompson of The Detroit Edison Company was present throughout the test as an observer. A test of a stoker-fired boiler in the same plant showed a gross efficiency of 75.8 per cent. The comparative efficiencies after accounting for coal preparation and incidental charges were reported as 72.32 per cent versus 70.88 per cent, or a difference in favor of the pulverized-fuel system of 1.44 per cent. The results of the tests were reported in a paper prepared by the late Mr. John Anderson, which paper was distributed widely. Inquiries from everywhere in this country and from abroad flooded into the company's office and visitors clamored for admittance to inspect the installation. All of this showed the intense interest in the new idea of burning pulverized coal under stationary boilers.

In 1923 the Bureau of Mines published the results of a series

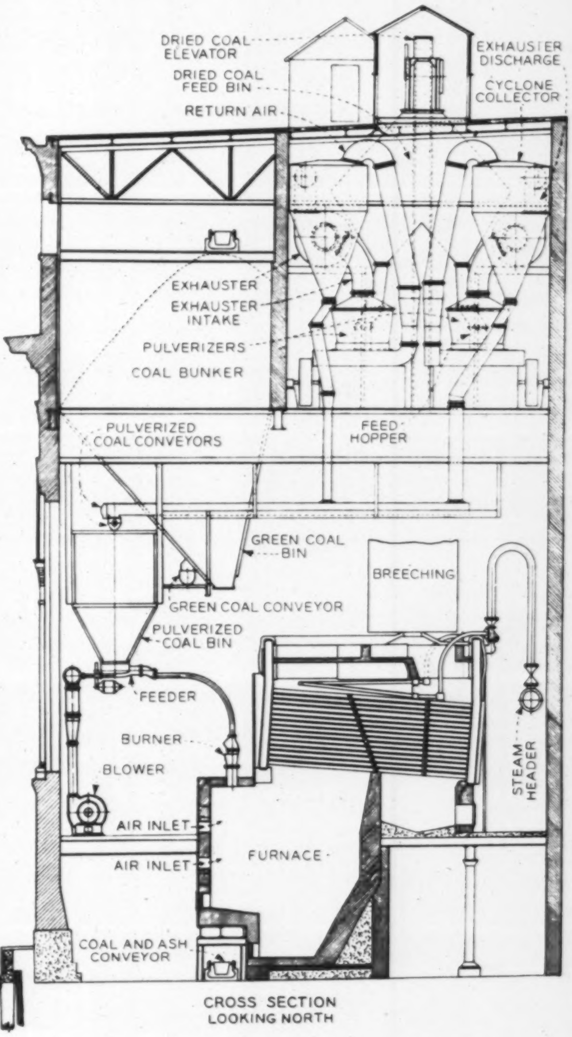

FIG. 1 CROSS SECTION THROUGH ONEIDA STREET BOILER PLANT
(The pulverized-coal installation was made on existing boilers and had to fit into the existing building.)

Contributed by the Fuels Division and presented at the Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948, of The American Society of Mechanical Engineers.

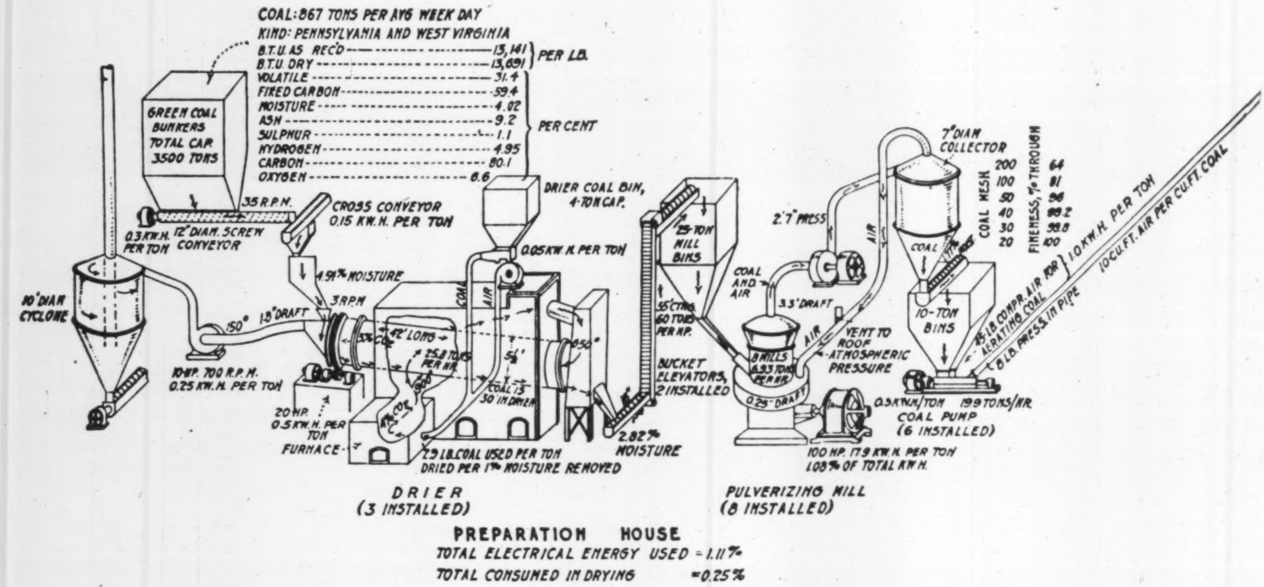
COAL: 867 TONS PER AVG WEEK DAY
KIND: PENNSYLVANIA AND WEST VIRGINIA
B.T.U. AS REC'D 13,141
B.T.U. DRY 13,691
PER LB.
VOLATILE 31.4
FIXED CARBON 59.4
MOISTURE 4.02
ASH 9.2
SULPHUR 1.1
HYDROGEN 4.95
CARBON 80.1
OXYGEN 6.6
PER CENT
GREEN COAL BUNKERS TOTAL CAP. 3500 TONS
35 R.P.M.
0.3 KW.H. PER TON
12" DIAM. SCREW CONVEYOR
CROSS CONVEYOR 0.15 KW.H. PER TON
DRIER COAL BIN, 4-TON CAP.
0.05 KW.H. PER TON
10' DIAM CYCLONE
4.91% MOISTURE
3 R.P.M.
1.3" DRAFT
150°
10 HP. 700 R.P.M. 0.25 KW.H. PER TON
42' LONG
5 1/2'
25.8 TONS PER HR
COAL 15 30 IN DRIER
COAL
AIR
650°
20 HP. 0.5 KW.H. PER TON
FURNACE
2.9 LB. COAL USED PER TON DRIED PER 1% MOISTURE REMOVED
DRIER
(3 INSTALLED)
25-TON MILL BINS
55 CTNS. 60 TONS PER HR.
BUCKET ELEVATORS, 2 INSTALLED
2.82% MOISTURE
2.7" PRESS
COAL AND AIR
3.3" DRAFT
AIR
8 MILLS 6.93 TONS PER HR
0.25" DRAFT
VENT TO ROOF
ATMOSPHERIC PRESSURE
100 HP. 17.9 KW.H. PER TON
1.08% OF TOTAL KW.H.
PULVERIZING MILL
(8 INSTALLED)
7' DIAM COLLECTOR
COAL MESH 200 100 50 40 30 20
FINENESS, % THROUGH 64 81 96 99.2 99.8 100
10-TON BINS
45 LB. COMPR. AIR FOR AERATING COAL
1.0 KW.H. PER TON
10 CU.FT. AIR PER CU.FT. COAL
8 LB. PRESS. IN PIPE
0.5 KW.H./TON 19.9 TONS/HR.
COAL PUMP
(6 INSTALLED)
PREPARATION HOUSE
TOTAL ELECTRICAL ENERGY USED = 1.11%
TOTAL CONSUMED IN DRYING = 0.25%

FIG. 2 DIAGRAMMATIC ARRANGEMENT OF COAL HANDLING AND COAL PREPARATION IN ORIGINAL LAKESIDE POWER PLANT, 1921
(Later designs eliminated most of the coal handling.)

of 38 tests made between June and December, 1920.[1] The tests were conducted by Messrs. Henry Kreisinger, John Blizard, C. E. Augustine, and B. J. Cross. The investigations were thorough and covered many phases of the subject, including following:

(*a*) Coal fineness.
(*b*) Coal moisture.
(*c*) Excess-air variations.
(*d*) Performances with round and spreading burners.
(*e*) Products of combustion.
(*f*) Furnace temperatures.
(*g*) Heat-absorption coils in furnace.
(*h*) Efficiencies of 64 to 84 per cent.

These tests showed that a coal fineness of 80–85 per cent through 200 mesh was unnecessary, and that fineness of 60–65 per cent through 200 mesh for coal being used was practically efficient. This permitted high capacities of mills and lower costs of preparation. The tests also showed that moisture reduction to 1 per cent was not necessary for efficiency, and that even undried coal could be burned efficiently. However, undried coal was found to give trouble in conveyers and in storage bins and affected mill capacity. The tests demonstrated that proper burner design, proper furnace design, and proper air admission were important factors in the process.

The tests, as well as the operating experience up to this time, revealed the advantages now obvious for burning pulverized coal, namely, wide fluctuations of load are possible in brief periods of time, and the quick response of furnace conditions gives the process a big advantage over other methods of firing. Maintenance of high CO_2, low CO, and reduction of combustible losses permit high efficiencies. Banking losses can be reduced to a minimum. Variable coal qualities can be accepted. Absence of moving metal parts in the furnace gives a maintenance advantage and reliability.

The need to reduce the costs of coal preparation, power requirements, and equipment maintenance, was a constant urge. Continuous and uniform operation of drier and pulverizer equipment with varying quality of coal presented never-ending problems.

LAKESIDE POWER PLANT

In 1916, before the war, the Milwaukee company had been making plans for a new power-generating station on the lake shore, south of the city. It was intended to install two 20,000-kw turbogenerators and eight 1306-bhp 300-psi boilers with stokers. The project had to be deferred because of the war. When it was resumed in 1919, a decision was made to fire the eight boilers with pulverized coal. This was a bold departure from the accepted practice of the day, and it was taken despite considerable differences of opinion and doubt among leading engineers in the country. For Lakeside, the storage system, sometimes called bin-and-feeder system, was adopted on the basis of the experimental installation at Oneida Street.

At Lakeside it was considered desirable to prepare the coal in a building separate from the boilerhouse. This building, called the pulverizer house, had a raw-coal bunker of 3500 tons capacity, Fig. 2. Coal was delivered to the bunker by 36-in. belt conveyers after being dumped from railway cars by a rotary car dumper, passed over a magnetic pulley to remove tramp iron, and then crushed by hammer mills to $^1/_2$-in. size. Coal from the bunker was conveyed by 16-in. screw conveyers to three rotary-drum-type coal driers like those used in cement manufacture and fired by pulverized coal. These three driers had an approximate capacity of 25 tons per hr each, reducing moisture from 5 to 2 per cent. The dried coal was handled by bucket elevators and distributed by screw conveyers to eight 7-ton per hr Fuller ball-type mills. The pulverized coal, separated by cyclone collectors, was deposited in bins to fuel pumps and was conveyed through 5-in. pipes, using compressed air, to the storage bins above the boilers in the boilerhouse.

Each of the eight boilers had three duplex screw feeders and six burners which fired the coal down through Lopulco fantail burners through an arch of the front wall of the furnace. The original furnace was built of solid refractory and had no water-cooling surfaces in bottom or sides of the furnace.

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[1] "An Investigation of Powdered Coal as Fuel for Power Plant Boilers," by H. Kreisinger, John Blizard, C. E. Augustine, and B. J. Cross, U. S. Bureau of Mines, Bulletin 223, 1923.

In 1925 the Bureau of Mines published the results of a series of 26 tests made during the period of May, 1921, to October, 1921.[2] These tests were made by the same four engineers who had made the 38 tests at Oneida Street 2 years previously, namely, Messrs. H. Kreisinger, John Blizard, C. E. Augustine, and B. J. Cross. As usual, these men were thorough, and their tests covered many phases of the subject. Efficiencies of boiler, superheater, and economizer were reported from 84 to 91 per cent. There is no question in the author's mind that the wide acceptance of pulverized coal on the part of the industry was due in a large measure to the painstaking care and thoroughness with which these test engineers performed and reported their findings under the direction of the United States Bureau of Mines.

EARLY PROBLEMS

At this point it is interesting to recall some of the early obstacles which had to be overcome in order to operate.

Handling Raw Coal. Conveying the raw coal was a major problem owing to seasonal variations of moisture and variations of fineness. Belt conveyers gave little trouble because they had been designed with ample margin in capacity, which usually is the best way to avoid trouble. On the other hand, screw conveyers gave much trouble, such as breakage of the screw flights due to clogging with wet and fine coal, breakage of weak bearing supports, undermotoring due to lack of accurate data for calculations, wear of the troughs, wear in chutes, corrosion in coal valves, and difficulty in getting an even feed of coal from bunkers into the conveyers. It became necessary to design and build special star feeders to get the coal out of bunkers.

Coal scales, which had been provided to weigh the coal into the rotary driers, gave difficulties which were solved only by the decision that the information these scales gave did not warrant the work necessary to keep them trouble-free, so they were eliminated entirely.

Preparing and Storing Pulverized Coal. Fires in rotary driers due to variations in moisture were frequent. Excessive dusting of the vents became a nuisance. Wear in the bearings and internal parts of these large rotating drums added to the work of the maintenance mechanics. Wear in the pulverizers was a

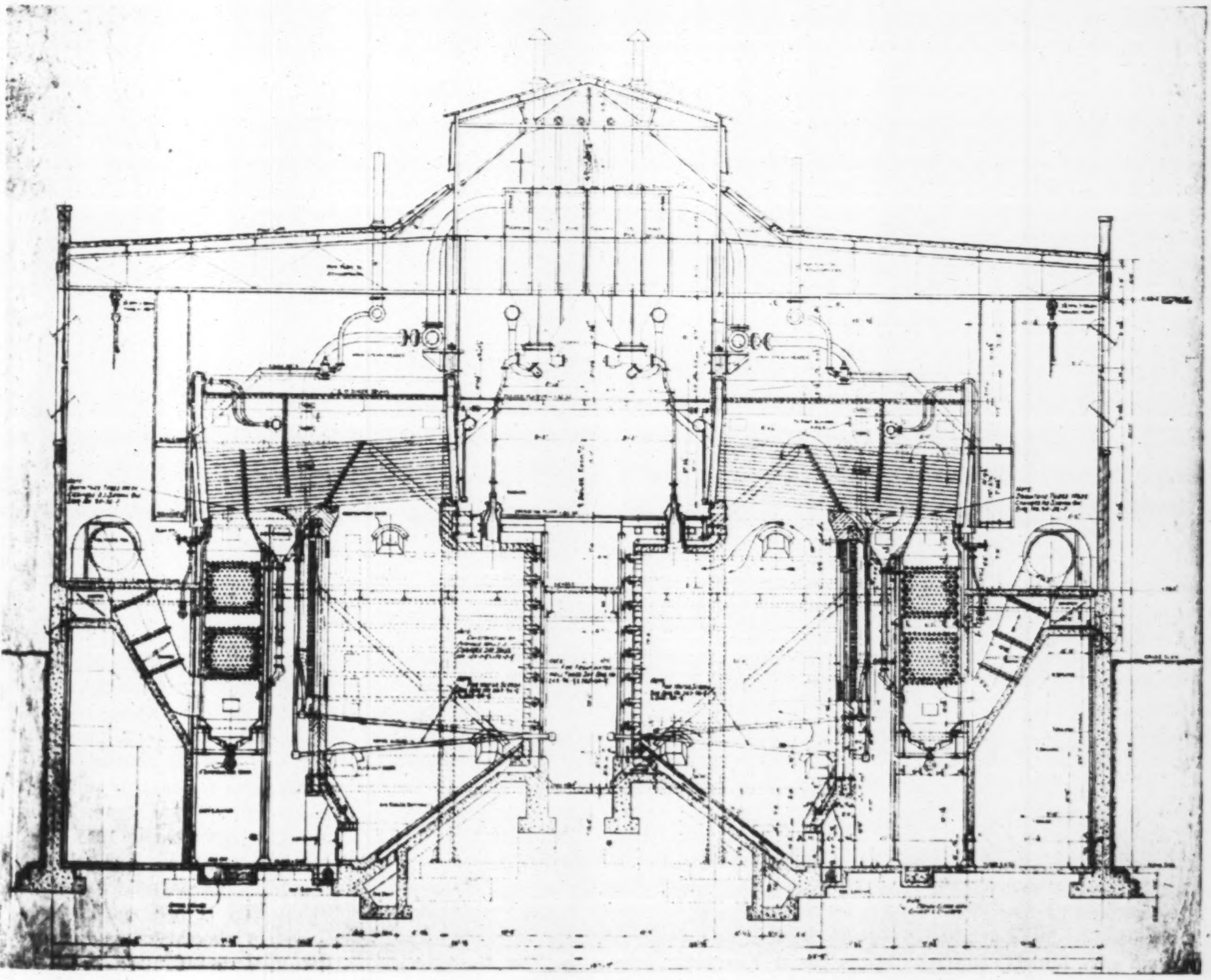

FIG. 3 CROSS SECTION THROUGH BOILER ROOM NO. 2, LAKESIDE POWER PLANT IN 1924
(All the refinements of previous years were incorporated in the design of boiler room No. 2.)

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[2] "Tests of a Large Boiler Fired With Powdered Coal," by H. Kreisinger, John Blizard, C. E. Augustine, and B. J. Cross, U. S. Bureau of Mines, Bulletin 237, 1925.

continual problem. The balls wore out of round and replacement was necessary. Coal-transport piping became clogged and required blowout connections. Wear in pipe bends required use of extra-heavy pipe wall, and seamless steel pipe was adopted to reduce the hazard of splitting of lap-welded pipe. Pulverized coal in storage bins suffered from condensation of moisture caused by cold drafts of air on the side of the bins. Insulation overcame the sweating to a large extent. The moisture also caused corrosion of the steel in the storage bin which was lessened by the use of insulation and erection of double-wall bins. It was also discovered that it is not good practice to make use of the structural-steel building beams to be a part of a coal-storage bin, or to run a beam through the inside of a coal-storage bin, because this steel is subjected to corrosion. Sufficient steepness of the valley angles of a bin was found to be a major consideration in the design of a self-emptying coal-storage bin.

Burning Pulverized Coal. Feeder screws wore and caused variations in coal feed and flooding of coal to the burners. New screws with various types of threads and materials were tried, and on later installations, the displacement type of feeder superseded the screw feeder. The original variable-speed belt drives required much mechanical adjustment, and on later installations, variable-speed direct-current-motor drives were used. Undermotoring of feeders was an initial difficulty.

Burning off of burner tips was reduced by changes in dimensions and by use of air admitted around the burner. Clogging of burners was reduced by changes in dimensions and means to rod out. Furnace designs were changed repeatedly to obtain the volume needed for burning pulverized coal and to add heat-absorbing surface in the furnaces to overcome slagging. In 1940 the author outlined the development of furnace design for pulverized-coal firing.[3]

In general, as each problem was faced and a solution was found, the system became essentially trouble-free and more reliable. Many troubles were avoided by adhering to guiding policies, as follows:

1 Eliminating a piece of faulty apparatus by substituting a new design, or if possible, a new method, such as elimination of screw feeders mentioned previously.

2 Providing a greater "margin of safety" when replacing a broken part.

3 Allowing more space in the layout to facilitate maintenance, and providing permanent trolleys and hoists to handle replacement parts.

4 Providing more margin in capacity of motors and gears.

5 Acquiring more skill and experience in operating, and encouraging suggestions for improvements from the operators. Providing the operating engineers with printed instruction books to explain the equipment they were required to operate.

LAKESIDE BOILER ROOM NO. 2

In 1923 the company added eight 1828-bhp 300-psi boilers to serve three additional turbogenerators, having a rating of 30,000 kw each. These new boilers had larger furnaces and were provided with screen tubes at the bottom of the furnace, connected into the boiler-circulation system. Radiant superheaters were added on the rear wall. The refractory settings were built with air-cooling ducts, and all the refinements developed during the preceding years were incorporated. A cross section of boiler room No. 2 is shown in Fig. 3.

The original milling capacity was not sufficient to serve the old and new boilers, and two 15-ton per hr Raymond roller mills of the latest design were installed in the pulverizer house. Coal drying preceding the milling had been a constant problem, and it was decided to add gas driers and later steam driers of a vertical type instead of horizontal rotary driers. These new driers were not successful because they had too low a capacity with wet coal, dusted excessively, and wore to such an extent that leaking of steam often offset the drying that was desired. It was not until the advent of drying coal in the mill, using hot waste flue gas, that the major problems of drying coal and maintaining full mill capacities were solved. Drying the coal in the mill with waste gas improves the over-all boiler efficiency about 0.5 per cent. Elimination of the coal driers and conveyers permitted reductions in investment costs. Drying coal in the mill was discussed in 1940, by the late Mr. M. E. Fitze.[4] However, there still remains a problem of controlling some coal dust escaping with the moisture-laden vented gas.

LAKESIDE BOILER ROOM NO. 3

In the period of 1926 to 1930, the company installed at Lakeside four 300,000-lb per hr, 1200-psi boilers with radiant superheaters and reheaters, Figs. 4 and 5. The mills were placed adjacent to the boilers in the boiler room for convenience. Again, all the refinements of the previous years were incorporated.

DIRECT-FIRING OF PULVERIZED COAL AT EAST WELLS STREET

The Milwaukee company has one installation of a direct-fired boiler and is not without some experience in burning pulverized coal directly. This installation consists of a 1000-bhp 200-psi boiler for central steam heating in the previously named Oneida Street plant. This boiler has a furnace of 6800 cu ft volume, waterwalls, air heater, but no superheater. It is fired by two impact mills and has two round burners in the front wall for horizontal flame. This boiler has been operating since 1926 and has done a very successful job. It is now practically trouble-free, although its safe range of load is limited.

PORT WASHINGTON

In 1930 the Milwaukee company began the design of a new power plant at Port Washington, Wis., 26 miles north of Milwaukee on the lake shore. The first unit of 80,000 kw capacity was completed and went into operation in November, 1935. The unit is a single-boiler single-turbine design in which the boiler is 690,000 lb per hr capacity, 1390 psi, and has radiant superheaters on the side walls of furnace, radiant reheaters on the rear wall of the furnace, and finned water tubes on the front wall and under the arch.

Duplex displacement feeders, ten in number, feed the coal to the twenty burners which fire vertically through the arch of the front wall. Variable-speed direct-current motors control the rate of feed automatically, and the fuel and air are regulated by steam flow - air flow which permits partial or complete automatic control or manual control. Coal is milled in two 15-ton per hr Raymond roller mills and is transported by compressed-air fuel pumps to the bin above the boiler.

A second 80,000-kw unit began operation in 1943, a third 80,000-kw unit was placed in operation in 1948, and a fourth 80,000-kw unit is on order. A cross section and views of the installations are shown in Figs. 6, 7, 8, and 9.

Some examples of the mill-system refinements incorporated in the Port Washington installations are as follows:

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[3] "Development of a Major Principle in Pulverized-Coal Firing," by F. J. Dornbrook, Trans. ASME, vol. 63, 1941, pp. 261–266.

[4] "Mill Drying of Coal," by M. E. Fitze, Trans. ASME, vol. 63, 1941, pp. 273–276.

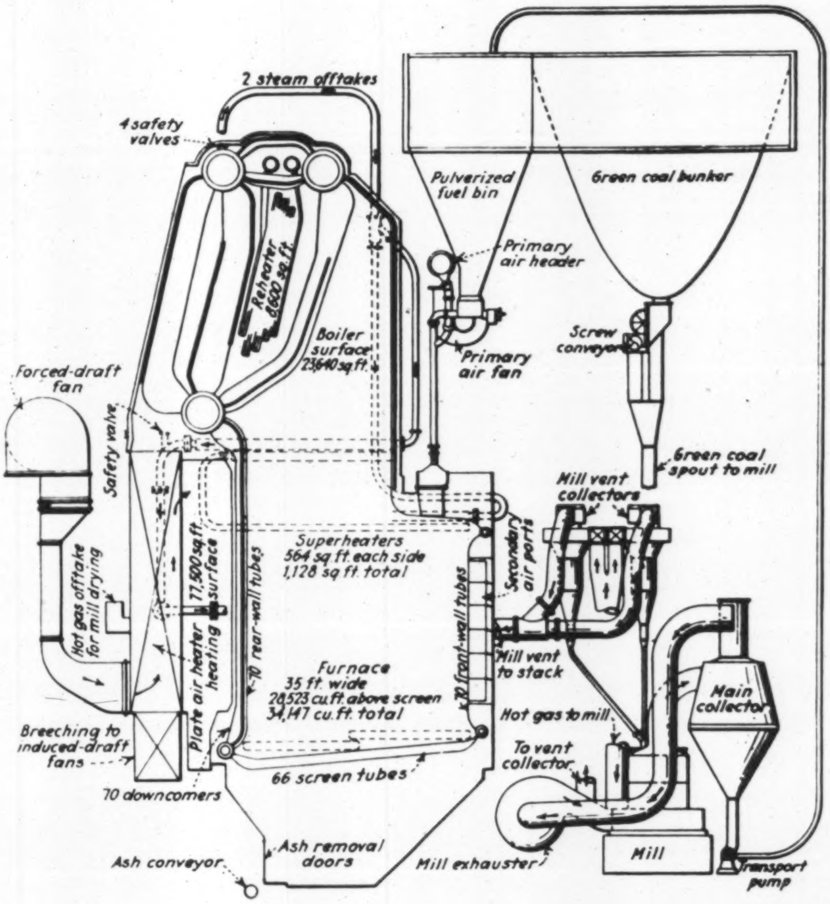
2 steam offtakes
4 safety valves
Pulverized fuel bin
Green coal bunker
Primary air header
Reheater 8600 sq.ft.
Boiler surface 23,640 sq.ft.
Primary air fan
Screw conveyor
Forced-draft fan
Safety valve
Green coal spout to mill
Mill vent collectors
Superheaters 564 sq.ft. each side 1,128 sq.ft. total
Secondary air ports
Hot gas offtake for mill drying
77,500 sq.ft. heating surface
Plate air heater
70 rear-wall tubes
70 front-wall tubes
Mill vent to stack
Furnace 35 ft. wide 28,523 cu.ft. above screen 34,147 cu.ft. total
Main collector
Hot gas to mill
Breeching to induced-draft fans
To vent collector
66 screen tubes
70 downcomers
Ash removal doors
Ash conveyor
Mill exhauster
Mill
Transport pump

FIG. 4 CROSS SECTION THROUGH BOILER NO. 19, LAKESIDE POWER PLANT, 1929

(The three-drum bent-tube boiler is located over a furnace with water andsteam-absorbing surfaces.)

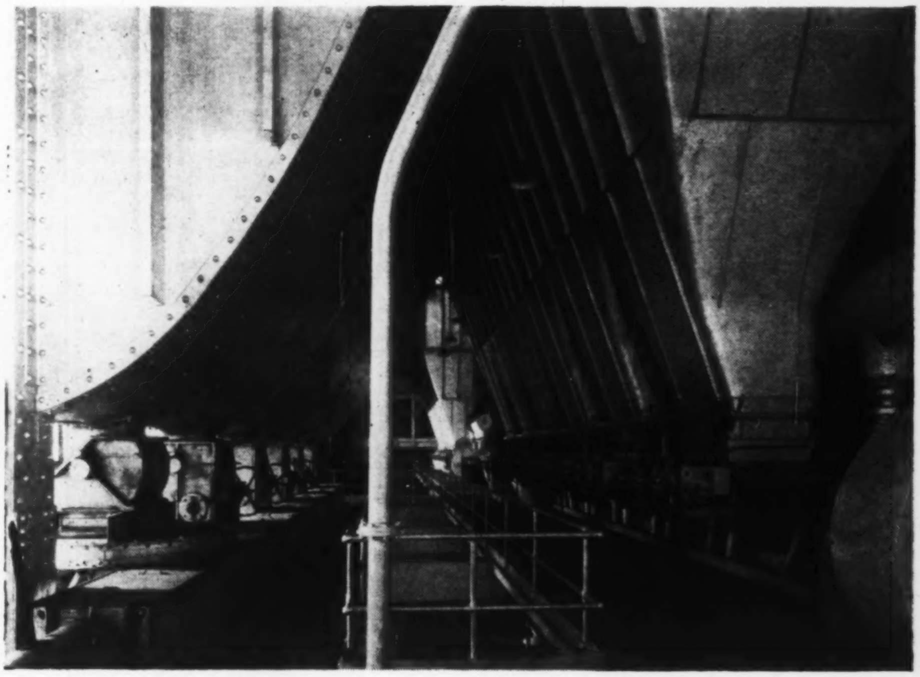

FIG. 5 PULVERIZED-FUEL BIN FOR BOILER NO. 19 AND RAW-COAL BUNKER, 1929

(Steep sides and insulation on pulverized-fuel bin insure flow of coal. Note special feeders to remove coal from bunker into screw conveyer.)

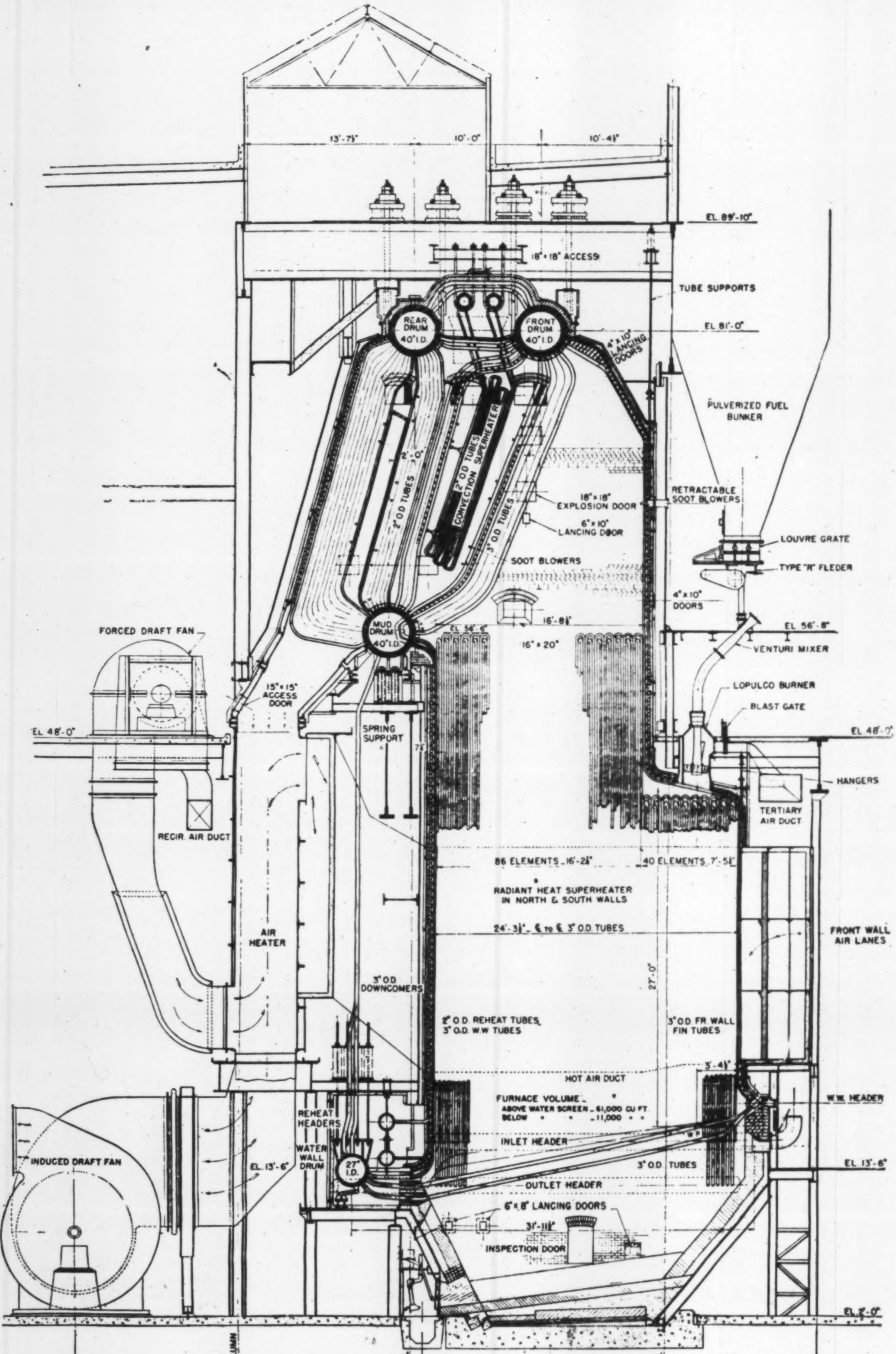
13'-7½"
10'-0"
10'-4½"
EL. 89'-10"
18"×18" ACCESS
TUBE SUPPORTS
REAR DRUM 40" I.D.
FRONT DRUM 40" I.D.
EL. 81'-0"
4"×10" LANCING DOORS
PULVERIZED FUEL BUNKER
2'-0"
2" O.D. TUBES
2" O.D. TUBES
CONVECTION SUPERHEATER
3" O.D. TUBES
18"×18" EXPLOSION DOOR
RETRACTABLE SOOT BLOWERS
6"×10" LANCING DOOR
LOUVRE GRATE
SOOT BLOWERS
TYPE "R" FEEDER
4"×10" DOORS
FORCED DRAFT FAN
MUD DRUM 40" I.D.
EL. 56'-6"
16'-8½"
EL. 56'-8"
16"×20"
VENTURI MIXER
15"×15" ACCESS DOOR
LOPULCO BURNER
BLAST GATE
EL. 48'-0"
SPRING SUPPORT
7½"
EL. 48'-0"
HANGERS
RECIR. AIR DUCT
TERTIARY AIR DUCT
86 ELEMENTS 16'-2½"
40 ELEMENTS 7'-5½"
RADIANT HEAT SUPERHEATER IN NORTH & SOUTH WALLS
AIR HEATER
24'-3½" ℄ TO ℄ 3" O.D. TUBES
FRONT WALL AIR LANES
27'-0"
3" O.D. DOWNCOMERS
2" O.D. REHEAT TUBES
3" O.D. W.W TUBES
3" O.D. FR WALL FIN TUBES
3'-4½"
HOT AIR DUCT
FURNACE VOLUME
ABOVE WATER SCREEN 61,000 CU FT
BELOW 11,000
W.W. HEADER
REHEAT HEADERS
INLET HEADER
WATER WALL DRUM
27" I.D.
INDUCED DRAFT FAN
EL. 13'-6"
3" O.D. TUBES
EL. 13'-6"
OUTLET HEADER
6"×8" LANCING DOORS
31'-11½"
INSPECTION DOOR
EL. 2'-0"
℄ COLUMN
℄ COL.
℄ COL.
13'-1"
13'-8"
20'-4"
12'-0"

FIG. 6 CROSS SECTION, BOILER NO. 2, PORT WASHINGTON POWER PLANT, 1943

(The three-drum bent-tube boiler is located over a low-heat-release furnace with radiant superheating and reheating surfaces on furnace walls. Hydro ash-sluicing troughs in bottom of furnace.)

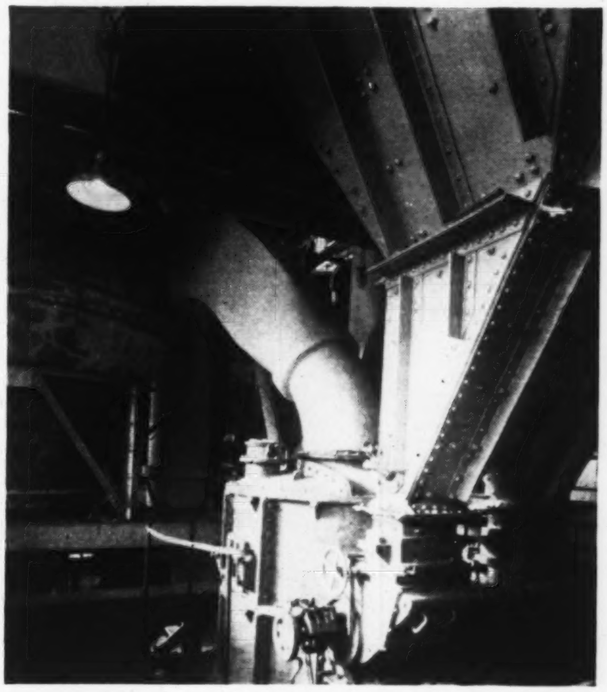

FIG. 7 BOTTOM OF RAW-COAL BUNKER AND MILL INLET, PORT WASHINGTON POWER PLANT

(Steep sides at spout from bunker to mill have renewable wearing plates and there are no ledges to impede flow of coal.)

1 Improved lubrication of mill parts and mill auxiliaries.

2 Wearing parts easier to replace and redesign of internal parts to reduce wear.

3 Use of press fits for gears and cranks on their shafts.

4 Interchangeability of spare parts and spare motors.

5 Use of butterfly valves instead of gate valves where possible, improved shutoff gates, greater tightness of puff doors and inspection doors, and stronger flanges in ductwork joints to insure tightness.

6 Thicker metal in ductwork where corrosion was experienced.

7 Guniting inside of cyclone collectors and fuel bins with concrete over mesh-wire cloth.

8 Interlocking mills and auxiliaries to insure correct starting sequence and complete trip-out in case of failure of any auxiliary, interlocking, also, the lubricating-oil pump for the mill, and interlocking the air supply to the fuel pumps.

9 Improved design of raw-coal bunker with steep sides which can empty itself completely, and enlarged connections between bunker and mills and elimination of ledges which would impede flow of coal.

10 Added indicating and recording instruments to assist the operators.

In developing refinements, formal tests were made following each redesign of a part. Tests were made on grinding rings, number of rollers to get best results, air ports, baffles, plow tips, cyclone collectors, exhauster fans, and venting, in a never-ending struggle for improvement to increase capacity, to reduce power requirements, to reduce maintenance costs, and to improve reliability.

The equipment manufacturers have always been very co-operative in a joint effort to improve the apparatus, and a large measure of credit should be given for their contribution to the successful developments of burning pulverized coal.

SOME FEATURES OF MILWAUKEE'S DESIGNS

One feature of Milwaukee's designs for burning pulverized coal which should be mentioned is the use of dual forced-draft fans, dual induced-draft fans, and dual primary-air fans. Double fans permit a flexible range in loading, greater reliability, and ability to continue to operate at about 60 per cent capacity with a single fan, in case the other fan or its drive is out of service for repair. The use of dual auxiliaries has permitted long periods of continuous operation of the units.

Another feature of Milwaukee's method of burning pulverized coal is the use of large water and steam-cooled furnaces to avoid the formation of slag in so far as possible. It is realized that the larger furnace costs more and requires a larger building, but the engineers of the Milwaukee company firmly believe that the additional cost is warranted by freedom from slagging troubles. The maximum rate of heat release is in the neighborhood of 15,000 Btu per cu ft. The use of maximum cooling surfaces, water and steam, and the minimum of refractory results in the low temperature and freedom from slag troubles.

To remove furnace-bottom ash from pulverized-coal furnaces, Milwaukee has found the sluicing-type ash conveyers to be satisfactory and therefore sluicing conveyers are used wherever the site and conditions permit. The ideal system is one in which the ash can be sluiced in a trough to an ouside dewatering pit without the need of clinker grinders or pumps to handle ash. Pumping the water from the settling pit, minus the ash, is not a difficult problem. Previous designs required removal of ash from furnace bottoms with manual and mechanical hoes,

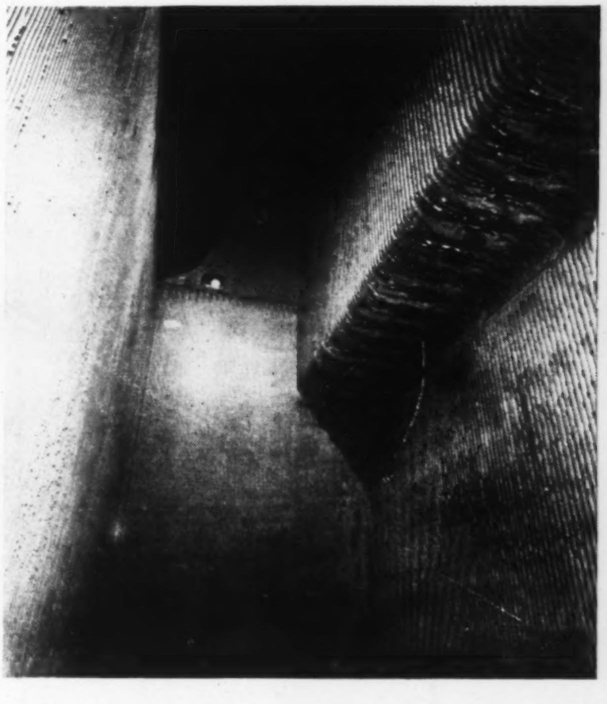

FIG. 8 INTERIOR OF FURNACE, PORT WASHINGTON POWER PLANT

(The use of maximum heating surfaces and low heat release keeps the furnace free of slag accumulation and permits long periods of continuous operation. This view shows condition without cleaning after 6 months operation.)

but the present system of sluicing the furnace bottom eliminates personnel accidents and avoids the kind of fatiguing work which discourages the employment of men who could be trained to higher positions in the plant. Sloped troughs are built in the furnace bottom, and ash is removed by water jets, by placer-mining the ash into a trench. The layer of ash keeps the bottom of the furnace relatively cool, and the refractories have been surprisingly free from trouble due to contact with water.

When burning pulverized coal, more soot blowers will be required with the steady deterioration of quality of coal and shortage of labor. Various types of retracting soot blowers have been tried and installed to eliminate hand-lancing at hot locations, and the latest installation will have air puff blowers in the boiler passes with remote control of automatic-sequence blowing.

ADVANTAGES OF BIN-AND-FEEDER SYSTEM

Milwaukee's method of firing pulverized coal is almost exclusively of the bin-and-feeder type. Advantages of this method are as follows:

1 Coal is stored in the bins during the off-peak periods to be burned during the peak-load hours. Such a system requires fewer mills and can utilize mills of the most economical size for pulverizing, because the size and design of mills are not prescribed by the variable requirements of the boiler.

2 The bin-and-feeder system permits the mills to operate at constant load and under conditions most favorable for high mill output, for controlled quality of pulverization, and for low milling costs. On the other hand, the boiler can be fired without reference to control of the mills. The functions of each can be controlled independently of each other and to the advantage of each.

3 The mills of the bin-and-feeder system at Port Washington have a pulverized-fuel transport system which permits coal to be furnished to any boiler from any mill. Hot-gas and vent ducts also are arranged so that mills can operate without the adjacent boiler being in service. This "help your neighbor" feature permits maintenance of mills to better advantage and avoids curtailment of load on boilers because of mill outage.

4 The bin-and-feeder system permits control of the flame and flame position necessary with use of radiant superheaters and radiant reheaters in the control of steam temperature. The Milwaukee company employs the radiant superheater and the convection superheater piped in series, to give a flat temperature characteristic throughout the wide range of boiler capacity. It also employs a radiant reheater in combination with the variable exhaust temperature from the high-pressure turbine to produce a flat temperature characteristic of reheated steam throughout the range of load. Constant steam temperature, as every engineer knows, is desirable for efficient and safe operation of turbines. The use of the bin-and-feeder system with radiant steam-heating surfaces gives a control of steam temperature not possible with some other types of firing.

5 Explosion in mills and fuel-storage bins has been nonexistent since use was made of waste flue gas in the mill for drying and for ventilation of the storage bin.

CONCLUSION

As mentioned in the beginning of this paper, no claim is made that the method developed in Milwaukee for burning pulverized coal is the only method which may be used, but it has been successful and efficient as applied in Milwaukee.

It is hoped that the foregoing brief outline will show the development of burning pulverized coal and some of the problems which had to be solved in the evolution of the method used in Milwaukee. The development has been a process of constant improvement of mechanical details and constant refinement to achieve efficiency, lower costs, and reliability.

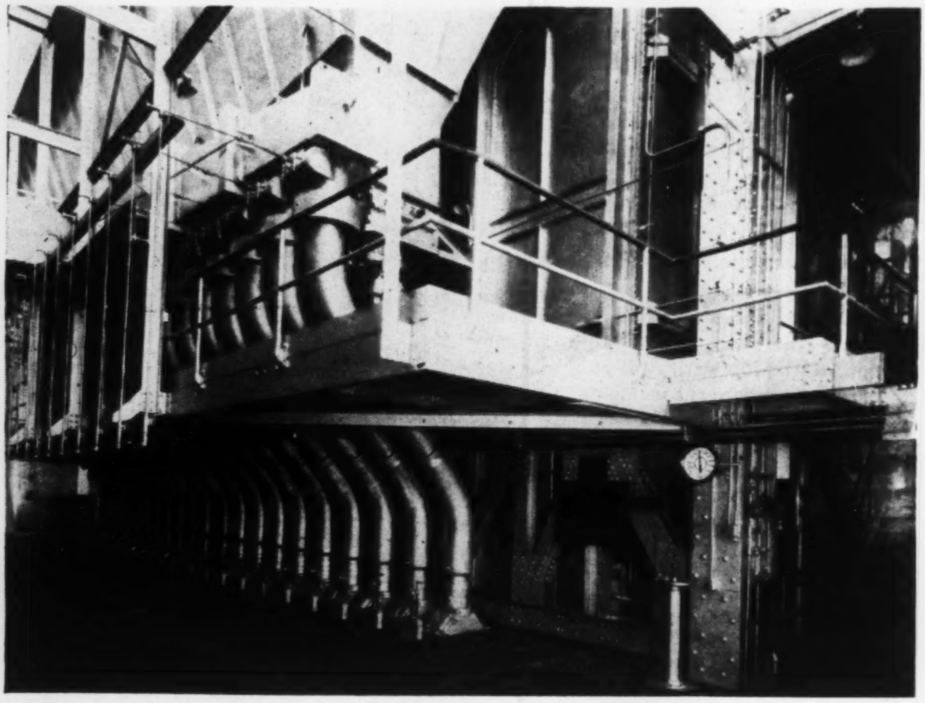

FIG. 9 FIRING ELEVATION, PORT WASHINGTON POWER PLANT
(Pulverized coal is fired vertically into furnace through 20 burners.)

The Status of HIGH-SPEED DIGITAL COMPUTING SYSTEMS

By HARRY D. HUSKEY

HEAD OF THE MACHINE DEVELOPMENT LABORATORY, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

A COMPLETE computing system may be said to consist of the following parts: (*a*) External memory, (*b*) input mechanism, (*c*) output mechanism, (*d*) internal memory, (*e*) computing element, and (*f*) sequence-control element. Let us first proceed to see how this division is represented in the older forms of computing systems.

EXAMPLES OF COMPUTING SYSTEMS

Take first a human computer who works with pencil and paper. The paper represents the external memory, the input mechanism is the eye reading symbols on the paper. The output mechanism is the hand and pencil. The internal memory, computing element, and sequence-control element, are all located in the brain of the computer. Now a human computer has many other facilities which do not contribute toward computing. In fact, many of these other facilities may be detrimental since they may distract the mind of the computer from the business in hand and lead to unreliable or intermittent operation. We note that although the potential supply of human computers is very great, the fact that they must be highly trained poses a definite problem. For example, not only must the brain of the computer know addition, subtraction, and the multiplication table; but it must know computation routines in order to perform the functions of sequence control. Furthermore, as we shall see, the human computer is exceedingly slow.

The first major improvement in the foregoing system of computing seems to have been the introduction of the abacus. The abacus took over the functions of internal high-speed memory (of rather limited capacity) and, to a certain extent, the functions of the computing element. Actually, the operator must still know digitwise addition and subtraction routines. The abacus served more as a high-speed memory in which partial results of computations could be stored.

A next improvement in computing came with the development of the desk computing machine. This development came about over a period of centuries, starting with crude mechanical devices and culminating in present-day electromechanical devices, such as those made by Marchant, Monroe, or Friden. These devices have taken over almost completely the functions of the internal high-speed memory, and the computing element. The human operator is left with the duties of transferring information between the external memory (paper) and the machine, and of providing sequence control. These machines have taken over some of the sequencing duties to a certain extent. For example, there exist models of these machines which carry out automatically the various steps involved in multiplication and division. Certain versions of these electromechanical computers incorporate an output mechanism producing printed results on paper. Note that, since the operator may read the numbers from it, this paper forms the external memory.

A next step in the development came with punched-card equipment. The idea of using punched cards for digital computing goes wayback to an analytical engine proposed by Charles Babbage in England (1).[1] However, he was plagued by mechanical-engineering difficulties, and the use of punched cards did not flourish until the developments of Herman Hollerith (2).

As a standard piece of accounting equipment, let us consider a tabulator. In this case the external memory is represented by the punched cards, the tabulator reads the cards, does a limited amount of computing, prints results on paper, or punches results in other cards via a summary punch. A limited amount of the sequence control is taken over by the machine. In this case printed results on paper are not part of the external memory since the machine cannot read them.

Thus a punched-card computing system consists of a number of punched-card machines (3). These machines perform the functions of input, output, and computing, entirely automatically. Local bits of predetermined sequencing are also done by the various machines. The major sequencing is done by one or more human operators by inserting the proper plugboards and by routing the cards through the machines in the proper manner.

In recent years there has been development of a number of very large automatic-sequenced computing machines based on mechanical counters (4) and on relays (5). These machines have received their sequence instructions from punched paper tapes and have punched their answers on other tapes, or IBM cards, and in some cases have directly produced typewritten results. In these machines we see that all the items mentioned as components have been made automatic. How, then, can they be improved?

Upon more careful inspection it is observed that the routines which they perform must be laid out on the sequence tapes. In some of the machines certain predetermined fixed subroutines are possible. This is accomplished by shifting the control from the main sequence tape to short loops of sequence tape, and, when the subroutine is finished, the control is shifted back to the main tape. Now, these machines would be improved if a more flexible method of sequencing were available, and if they could operate at higher speed.

A step in the direction of speed was taken when the first substantially electronic computing machine was developed for the Army Ordnance Department at the University of Pennsylvania. This "electronic numerical integrator and computer"(6), or ENIAC, as it is called, receives its input data from punched cards and punches its results out on other cards. The sequencing is predetermined by the manner of putting in pluggable connections. The internal transfer of numbers, the computations, and the sequencing, are all done electronically. Therefore this machine operates at tremendous speed; a particular unit may do 5000 additions of ten-digit numbers per sec, and

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

another may do in 1 sec almost 400 multiplications of two ten-digit numbers.

The ENIAC with its 18,000 tubes may be thought of as a number of units each belonging to two telephone systems, one a party-line system, and the other a private-line system. The sequencing is represented by signals on the private lines. These signals cause particular units to perform transfers or arithmetical operations, and the party lines furnish a means of transmitting the numbers from one unit to another.

The method of sequencing on the ENIAC is unsatisfactory because of the difficulty in putting a new problem on the machine. The solution of this problem used in the relay machines (tape sequencing) is not fast enough for the ENIAC. Although very fast, the internal high-speed memory (about 200 decimal digits) and the input-output speed (about 200 decimal digits per sec) are each small compared to the speed of the computing elements. On the other hand, all nonelectronic machines are relatively slow; so, at the moment, the ENIAC is still the fastest computing machine in existence. We should note that the ENIAC was not designed as a general-purpose computing machine, and that it is well-suited for its designed purpose of computing firing tables or any other highly repetitive job in which the changing of the interconnections occurs infrequently.

Thus we see that the ENIAC represents a tremendous improvement in speed of computing at the price of difficulty in changing problems. We should note that new developments are now being incorporated into the ENIAC to increase the internal memory and to facilitate a new method of programming which avoids the interconnection-changing problem.

PROPOSED MACHINES

The proposed machines differ from existing models in almost all the characteristics listed at the beginning of this paper. Existing machines have internal memories in the form of mechanical wheel counters, relays, or electronic ring counters. The proposed machines expect to have memories in the form of acoustic-delay lines, electrostatic storage tubes, or magnetic drums.

The most successful form of acoustic-delay line (7) consists of a column of mercury with crystal transducers at each end. A train of pulses arriving at the input crystal causes it to vibrate, producing sound waves in the mercury column. The sound waves pass down the mercury column at about 5 ft per millisec. Thus a string of 2000 pulses, occurring at a 2-megacycle rate, could be sent to the input crystal before the first of these would appear at the other end of the mercury line.

The pulses which appear at the end of the delay line are much smaller and of very different shape than those that go in. Thus these signals are amplified and used to "gate" pulses of standard shape. These gated pulses may be fed back to the input of the delay line, producing a delay-line memory. That is, once a particular pulse train is started, it will continue to circulate down the delay line back through the amplifier and gating circuits to the input of the delay line, and so forth. Contractors of the Bureau of Standards have demonstrated delay-line memories of this type successfully at pulse frequencies as high as 5 megacycles.

The charge storage tube is being developed in a number of forms. One form using standard cathode-ray tubes is being developed at Manchester University in England by F. C. Williams. He has stored 2048 pulses in a 12-in. tube. The system involves reading lines on the tube at a relatively slow rate, so the pulse frequency is equivalent to about 125 kc.

Developments in this country have concentrated on much faster methods of reading the stored numbers. In this respect RCA is developing a tube called the "Selectron"(8). The Selectron is noted for its grid switching arrangement which gives absolute positive return to a given place on the storage surface.

There are other developments depending only on amplitude methods for locating points on the storage surface, but using essentially the same principle of storage as the Selectron.

A rotating drum whose surface consists of magnetic material can remember pulses in the form of magnetized spots on the surface. In this case the pulses on the drum pass by the reading station, giving a cyclic memory somewhat similar to that of the delay lines. One notable characteristic of the magnetic drum is that there is no loss of memory, even in case of power failure.

In existing large-scale computers, the external memory has been either punched cards or punched paper tape. Most of the new machines will have magnetic tape or wire memory. This medium is compact, durable, and erasable. One objectionable quality is the fact that one cannot pick up a piece of tape and read what is written on it; in fact, one cannot even tell whether anything has been written on it.

Machines using punched-card inputs have an input speed of about 150 cards per min, or approximately 200 decimal digits per sec at most. The art of handling magnetic tape has advanced to the point where it seems certain that 10,000 decimal digits can be read into the computer from one magnetic tape in 1 sec.

With the increase of input-output speed, the development of large internal high-speed memories, and fast-computing facilities, these machines become an order of magnitude more powerful than previous machines. A person with pencil and paper may be able to multiply 2 ten-digit numbers together in about 5 minutes, one of the new machines will probably be able to do this in not more than 1 millisec. On this basis the machine is equivalent to a quarter of a million people. In fact, inasmuch as the machine is not subject to labor troubles or political strife, it would seem that this is a conservative comparison.

It is probably more realistic to compare the machine with a group of people working with desk calculators. Let us say that it takes ten people to keep such a machine in operation, and suppose that the machine is equivalent to 25,000 human computers working with desk calculators. Or, in other words, such a machine in operation for 1 hour does the work of ten human computers in 1 year. Furthermore, some of the machines (9) now planned will be faster than this by a factor of 4.

Such computing machines are dumb in the sense that they will not recognize any absurd or impossible situation unless they are instructed to. For example, suppose that the flight path of a bullet is being computed, and the height of the projectile turns out to be a negative number, meaning that the bullet is flying merrily along underground. The human computer, it is hoped, would recognize the situation as being nonsensical and refer to his supervisor for further instructions. The persons instructing the machine must foresee all such possibilities, or several thousand man-hours of computing may be wasted in a few minutes. Thus a great deal of responsibility must be placed upon the people who operate the machine.

For similar reasons, the question of machine failures must be considered carefully in designing such machines. It is essential that any errors made by the machine are detected within a very short time in order to have efficient operation.

It has been shown that a computing machine designed in a manner similar to any of the proposed machines would be absolutely general, provided it has an infinite memory (10), that is, it would be absolutely general in the sense that it could be made to imitate any other computing machine merely by giving it the appropriate instructions. The external memory of the presently planned machines consists of about 1,000,000 words, which seems near enough to infinity for all presently foreseeable purposes. This means there can be no essential improvement upon the present machines except in respect to the rate at which they can do certain types of problems, and the reliability with which they operate.

This property of generality can be further emphasized by pointing out other applications of the machines, that is, although the most important application is in the field of computing, the machines may also do any type of substitution problem which can be solved by the application of a limited number of rules. The "words" which these machines remember may be actual words as well as digital information. Since the machine can perform any fairly elaborate scheme of substitution, it could translate from ordinary telegraphic codes to standard English, and, in fact, could probably do a mediocre job of translating from any foreign language into another.

A more interesting problem is whether the machines could be made to translate the ordinary mathematical language into actual coded instructions for a particular machine, that is, can the machines do their own coding of problems?

FURTHER IMPROVEMENTS IN THE MACHINES

It has been indicated that the proposed machines represent the accomplished mechanization of all the items listed at the beginning of this paper, and that they accomplish their duties at high speed and in a very flexible manner. On the other hand, even though the present machines are general and further improvements in the computing system seem to be mainly a matter of increased speed and reliability, there are auxiliary problems whose solution would be very welcome.

It is clear that the machines can process data very efficiently if such data are in a form which they can read. Here remains a major bottleneck! Somewhere a group of people must be laboriously handling sheets of paper and manually punching typing machines which transcribe the data into a form readable by the machines. For example, in transcribing the data taken in the 1950 census, about 3000 people will be doing the job, and they will process about twenty carloads of paper forms. How nice it would be if the machines could read the paper forms!

Likewise, the problem of transcribing from the machine recording medium to sheets of paper is a major problem. At the moment it seems probable that printing machines can be designed for a not unreasonable cost which will transcribe at 300 lines of type per min. Speeds much greater than this bring major mechanical difficulties.

There are groups of people working on both these mechanical problems, but no startling advances are in sight. This is another place where we need new ideas.

COMPUTING AND SCIENCE

It might appear that the advent of the new high-speed machines would make the old slower machines obsolete. However, this is not so. There will always be a place for hand computing, for desk machines, for relay machines, and for electronic machines. To prove this point, consider the totality of computable problems as having measures of complexity which range from zero for simple problems on the one hand, to arbitrarily large numbers on the other hand. With pencil and paper we are able to attack those problems lying close to the origin in this representation. Larger and faster computing machines enable us to attack problems lying in intervals farther out on this complexity axis. Each type of computing system will have its place on this axis where it solves problems most efficiently. Furthermore, any short interval on this axis has essentially an unlimited number of problems in it. So each machine can be kept busy on the class of problems which it does efficiently.

The science of computing, the techniques of computing, and the general knowledge in each scientific field have been remaining essentially abreast of one another over the years. At the moment we are at the threshold of a period inaugurated by a stupendous advance in the ability to carry out elaborate computational routines. This advance stems from recent advances in electronics and physics which make such computing machines possible.

Now, mathematicians must re-examine all numerical methods. Perhaps some of those discarded as unsuitable for pencil-and-paper methods will be the best for these machines. New methods must be devised for problems heretofore intractable because of their complexity.

These machines emphasize a different phase of mathematical research. When it comes to applying the machines, an existence theorem concerning the solution of a problem is not sufficient. What we want is the existence of a solution computable on our machines. For example, it would not be sufficient merely to know that a certain infinite series converged, we must know that it converges fast enough.

Physicists and engineers have at hand a new and extremely powerful tool. They must learn of its powers and make use of them. With the greater ability to use applied mathematics there must be more applied mathematicians. That is, more applied mathematicians must be trained and industry must learn to make more use of them.

In spite of the optimistic note of this paper the millenium for computing machines is not yet at hand. There are many problems easy to formulate whose solution involves so many steps that even these high-speed machines would take thousands of years in solving them. There are also problems which cannot yet be formulated, since the theory is not sufficiently well understood.

THE UNIVERSAL MODEL

A computing machine can also be interpreted as a model. It is standard practice to build prototypes, to construct models, and to test them, and to make pilot runs in industrial processes. Illustrations may range from the problem of the placing of machines on factory floors, the test-firing of a V-2 at White Sands, the testing of model airplanes in wind tunnels, to the dropping of test bombs on Bikini. Many of these tests are extremely expensive to perform, and in some cases the test involves destruction of capital equipment and only incomplete records can be taken.

The results of some of these model experiments can be produced mathematically. The advent of automatic high-speed computing machines is a tremendous and significant step in this process, since they will substitute as a universal model for a large class of these model experiments. In order to get the results mathematically two assumptions must be satisfied: (*a*) The physical problem must be described completely by known mathematical equations or relations. (*b*) The numerical procedures for solving the relations must involve only a reasonable number of steps (say, not more than a few years of work on one of the high-speed machines).

Whenever these two assumptions are satisfied the problem can be solved on the computing machine and complete results can be obtained, that is, the computing machine serves as the model.

In many situations assumption (*a*) is not fulfilled. In other cases assumption (*b*) is not fulfilled. Thus the future should see a concentration of effort in mathematical physics and on numerical methods, and a further effort to increase the speed and efficiency of the computing machines.

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ENGINEERING RESEARCH[1]

L. M. K. BOELTER

DEAN, COLLEGE OF ENGINEERING, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIF.

A DISCUSSION of research in mechanical engineering should include an inquiry as to what engineering research is, whether it should exist and whether it should be fostered in engineering schools and their research organizations which are often only loosely knit or only in the industry and finally whether the responsibility can and should be shared between the schools and industry.

Research may consist of discovering whether a given operation is rational and thus predictable from known laws. More often experimental work is designed to discover the behavior of an ideal system.

The experimental determination of the behavior of an actual engineering system is normally designated as testing and as such cannot be called research. However, if these data are taken with care, precision, and judgment they may serve as a basis for research as defined above. Experimental determinations often yield erroneous conclusions if the system is not instrumented properly, the data are not properly taken and identified, and if the external variables are not properly controlled.

The experimental determination of the behavior of systems usually implies that the magnitudes of the variables are reduced to distances. Thus all force fields, including those to which the senses respond are included in a common measure.

The experimental results of the behavior of ideal systems are formulated numerically and algebraically and become known as fundamental laws. In general, our colleagues in the sciences perform this experimental work, formulate the laws, and confirm or deny hypothesis. How much of this type of research should be done in engineering? Will the large areas left incomplete by the physical scientist, as he is led to nuclear studies, be assumed by the engineer?

Whether or not the determination of properties of substances and materials is research remains to be answered. The distinction usually drawn depends on whether the determination requires a new method or not. In the former case the work is called research.

Again the development of engineering systems or portions thereof is often called research, although it would appear that progress on this front depends primarily on the intuitive applicant of physical phenomena to the problem at hand, sturdily supported by analytical and experimental (pilot or prototype) solutions.

What is the objective of research? Primarily the objective is to observe and formulate the behavior of nature for ease of transmission and utilization. A larger objective to those who are philosophically minded and intellectually curious is to demonstrate the unity of nature and to determine its ultimate structure. To what extent can and will modern engineers participate in the larger objective?

The formulation for ease of transmission is of vital interest to the pedagogue. Under mass education the information must be transmitted by others than the masters. Thus mass education would be impossible without adequate formulation.

Research in an engineering school can be defended thus far by virtue of its mass training implications. If research is conducted so as to reveal the behavior of systems to the senses other than to linearize them (by instrumentation) then the pedagogue acquires another powerful tool. A great weakness in engineering training today is the lack of "physical sense" demonstrated by many graduates.

The rate at which industry has accepted engineering research as a functional activity is directly related to the training programs in the engineering schools. Training of students for the research and development functions is still in its infancy. Research in an engineering educational institution can be defended additionally (to the pedagogical bases noted in the foregoing paragraphs) only if men are trained for the research and development functions and if industry wishes to share the engineering research responsibility with the schools.

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[1] Presented at ASEE Meeting, Monday, June 14, 1948, Austin, Texas.

TOOLS *and* TECHNIQUES *of* MANAGEMENT

By ROBERT W. ELSASSER

MANAGEMENT ANALYST, NEW ORLEANS LA.

This paper was not prepared as a technical presentation to specialists in administration. For that reason no attempt has been made to provide the usual footnotes. The influence of many minds is gladly acknowledged. Obviously, the subject matter is not new. It is hoped, however, that whatever merit the paper may have lies in the sequence and association of ideas to produce a pattern or template for thinking positively in analysis for action. Although still a hypothesis in the aggregate, the tools and techniques emerge from experimental or "clinical" and inductive methods, tested deductively for more than twenty years. The limiting assumptions usually respected in the social sciences are not regarded as restrictive, nor will they be offered as a defense against weaknesses that may appear in the reasoning. *The Author.*

THERE is an orderly and relatively precise method available in all management or administrative thinking. An understanding of the method rests upon definitions of terminology which are sharper than those ordinarily experienced. It rests also upon the acceptance and use of a few simple tools and techniques which facilitate analysis for decision and action.

The engineer's anxiety over changing the form or location of matter, over timing the transfer of energy, or reducing the waste of natural forces is usually tempered by his confidence in mathematical prediction. It is a confidence that is born of established principles and familiarity with limitations in their application. The art of application of scientific principle is above all things the art of detecting variations in actual conditions from laboratory conditions; it is the art of recognizing the departure of reality from the rigid assumptions or standards which by definition are so essential to the validity of the principle.

Should there be any wonder then that the trained technician who expects to find matter predictable is perplexed and impatient over the language of the social sciences? It may provide the engineer with some comfort to know that very few social scientists themselves are able to use the principles in the discussion of which they are so expert. This is no criticism of their inability. The explanation is that they have not given the application of social principle significant attention nor do most of them have any interest in application. They prefer to confine their thinking to those areas of abstraction that are "unsullied by practical application."

It is not surprising therefore to discover through experience that in the management of human affairs our language is inadequate, and that the first prerequisite of those who assume the responsibility of directing human affairs is the promotion of common understanding through the development and use of precise terminology. In our relationships with each other we may use the same words, but the chances are almost certain that significant words carry different meanings, or at best they are obtuse and tend to confuse rather than clarify. Every individual who seeks to increase his managerial capacities should become a student of semantics, if only for the proverbial fifteen minutes a day.

The weaknesses in language should never be forgotten in all administrative thinking until we produce a language of management that conveys precise concepts. It will always be the responsibility of management to produce organization unity in spite of the inadequacies of our communicating tool.

Despite the distinction between "management" and "administration" that is frequently made in some circles, the two terms are used synonymously for our present purposes.

It may be helpful to make a specific distinction between the "academic" and the "practical." In the former case we compare and relate facts, qualitative as well as quantitative, for their own sakes, in our "search for the truth." In practical affairs, though we may not take the time to define it, we have a different aim. The desire to attain or realize an objective prefaces the definition of a standard, and it must precede the recognition of problems in the pursuit of such aims.

The use of remedies rests on a knowledge of causes, of principles established or assumed. If they have been established, we are using the "tools" of science. If they have not been established, we accept hypotheses and then we experiment in action, because act we must. Otherwise we may be "speculating" or "theorizing."

BROAD SCOPE OF MANAGEMENT TECHNIQUES

The subject matter of this paper is presented without limitation in the areas of application. These tools and techniques have proved useful not only in the management or administration of a business unit, but also in the management of nonprofit educational institutions, hospitals, public projects, associations, and political groups. They have been proved useful in the management of the affairs of individuals.

It will become apparent that they are, in fact, the techniques of the art of engineering in human affairs, to focus attention upon and to provide standards for comparison, judgment, decision, and action.

Management is the direction of human effort in the pursuit of a specific purpose. The direction of an organization rests upon the sharp definition of that purpose and upon its communication to all individuals within the organization who are charged with some supervisory responsibility. Since management derives its authority ultimately from the individual or group endowed with the power of appointment, it is to be presumed that its purpose at all times must be acceptable to its source of authority. The executive committee of the board of directors, and the board itself are usually a significant part of management

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with ultimate authority resting in the stockholders collectively, under stipulations prescribed by law. Since those individuals who hold the residual equities in the assets of the business unit enjoy alone the privilege of selecting the personnel who are charged with management responsibilities, it is normal to find top management chosen for its sensitivity to the major aims of stockholders.

At the risk of diversion, let it be acknowledged that some conscientious students of administrative reform have insisted that employees and other groups with a direct interest in the affairs of a corporation should participate with stockholders in the selection of a "professional" management. They argue with some force that top management would be impelled to compromise group aims so as to anticipate and avoid conflict.

When, however, it becomes necessary to combine and direct the effort of two or ten thousand individuals, the primary unified purpose of the organization and its policies must be communicated to every individual who is charged with the exercise of discretion or with the co-ordination of the effort of subordinates.

The definition of aims and of policies is usually taken for granted and so receives no attention; or when an attempt is made to define them, thinking is sometimes muddy and incomplete. To insist without qualification that the aim of business activity is the realization of profit is shallow. To aim at immediate profit is to produce policies and action far different from those which would be produced under an aim of long-time profit or under the so-called twenty-year point of view. The classic conflict between "production for profit" and "production for use" is understood only after we compare the consequences of decision and action in each case. The definition of purpose for nonprofit units such as an educational institution, a hospital, or a chamber of commerce is an extremely difficult task, especially when one seeks the approval of many different minds in its acceptance. Then we discover that policies, like laws, qualify and limit purposes.

STATED AIMS AND ACTUAL PERFORMANCE

Even when the aim of activity has been clearly specified we must be sure that it is in fact the purpose which sparks all operations and control. Unfortunately, we can find numerous examples of obviously hypocritical presentation of aims in form for public consumption. Some group purposes, prepared for public consumption, glow with the warmth of interest in humanity; but they turn out to be pure fiction when tested by actual performance and decision. It is not unusual to discover that the true purposes of a business unit, as evidenced by action, differ widely from professed purposes. If there is any suspicion that these remarks about purpose tend to overemphasize the obvious, it will be instructive and revealing to compare statements of purpose independently prepared by executives within an established organization.

In the pursuit of a specified aim, the performance of work is the aggregate performance of function by selected personnel in accordance with a method or system which dictates the time and place for such effort. In other words, the major concepts inherent in building, directing, and analyzing an organization of human beings are those of (*a*) function, (*b*) personnel, and (*c*) system. Numerous authorities offer many more so-called principles or concepts in organization which suggest more elaborate detailed treatment. But experience has already indicated that the more detailed classifications of ideas can and should be assembled as subdivisions under one of these three major classifications. Whenever this division cannot be followed, it will be found that the "principle" or "factor" refers to aim, to policy, or to some other standard.

TEST OF A "GOOD" ORGANIZATION

The test of a "good" organization then is the extent to which it achieves the purposes for which it was built, at a minimum cost. It is idle and irrational to judge an organization in terms of purposes which we would impute to it. We make many errors in estimating performance by our own standards when it should be measured by comparison with those actually used by the individual responsible for doing a job or supervising it.

So, in the direction of human effort, it becomes necessary to establish a sharp concept of "control." Let us define control as the continuous comparison of actual conditions or performance with standard conditions or performance, that is, a comparison of "what is" with "what ought to be." If all conditions and all performance conform with management's standards, management has no problems. This is to say that a problem exists, and is recognized, only when actual condition or performance fails to conform with accepted standard. In this sense then, the specific definition of a problem must include reference to the facts as they are, in comparison with the standards by which management is judging the facts of condition or performance.

It should be noted, however, that the phraseology in the preceding paragraph is intended to refer to comparisons with standards already established, or defined and accepted as a basis for comparison. Therefore it becomes necessary to point out that many management standards are not what they ought to be; and therein lies another series of problems. Furthermore, the standards which should be used are subject to frequent change. At this point then, management should become sensitive to the necessity of testing the adequacy of all standards at all times, and management should never assume that any standard should become rigid and not subject to change.

QUALITATIVE STANDARDS OF MANAGEMENT

It may be wise to remind ourselves that aims are one form of standard, policies are another, and the usual quantitative operating standards suggest another form. But we should also not neglect the definition of significant qualitative standards when they become pertinent to problem definition and to remedial action. Unconsciously, we are always seeking to measure phenomena; and when we cannot measure them we make the mistake of ignoring or neglecting the qualitative influences in human affairs which are not measurable.

It should be acknowledged that the techniques in definition of qualitative standards call for special discussion because they usually entail special training. How can we, for example, define standards of loyalty, honesty, conscientiousness, intensity of effort, capacity to listen and follow instructions, or ability to sense significant demands of public-relations groups? Qualitative standards are generally vague. They demand capacity in abstract thinking and in weighing emotional influences without the aid of measurement devices.

Now let us apply this control tool to the concept of organization. Failure in the performance of organization occurs when the functions being performed are not what they ought to be, when the individuals in the organization are not producing as they should produce, and/or when the system of performance, especially with respect to timing, is not what it should be. Obviously, it becomes the responsibility of management to seek the reasons for variation of actual from standard in each of these three situations and to apply corrective measures.

ORGANIZATION ANALYSIS

Many organization charts are faulty because they have been conceived in confusion. The orderly presentation of the analysis of an organization requires a series of charts. The first chart should be one showing functional relations as they ought to be, without respect to personnel. The next chart should show functional relations as they are, without respect to personnel. A third organization chart should show personnel relationships as they ought to be, without consideration for the personalities or pressures of the individuals who occupy the defined positions. The fourth chart should show lines of authority and responsibility as they actually exist, with specific personalities occupying each position. If a comprehensive chart can be prepared which clearly includes all of these elements in the one presentation, so much the better. But the fear is that an adequate composite would simply promote confusion.

Other examples of the application of control suggest themselves readily. The usual operating ratios reflected in profit-and-loss statements and balance sheets are the obvious measures with which management is well acquainted and in the comparison of which most managements have already developed great facility. Yet it should be observed that even in this area judgment is flabby and indecisive whenever the appropriate standard has not been precisely defined. There are some situations entailing comparison with three or four different standards. According to one standard results are satisfactory, while according to another they are altogether unsatisfactory. Under these circumstances, it is essential that management select the standards which it seeks to meet.

REVENUE, COST, AND PRODUCTION ANALYSES

Sales quotas for territories, for products, and for individuals as well as groups are the most obvious standards in revenue analysis. Cost standards are widely used and well publicized but their interpretation and use have sometimes led to irregular action because their limitations were not understood.

Production control embodies the determination and use of thousands of standards of quantity, cost, and quality, in turn dependent upon the timing of the flow of internal and external traffic.

The estimate of an individual's or a department's contribution to performance can only be vague and useless unless there has been a reasonable standard of performance defined and understood by the individual as well as by his supervisor.

Conflict over estimate of quality arises frequently because inspectors have not been instructed properly to adopt a uniform standard. Numerous problems and costs have resulted from the failure to reconcile quality standards when they are dictated by different agencies which may have some jurisdiction over output.

Is there any administrator who has never had the experience of resorting to compromise to produce a single concept of what ought to be?

EXTERNAL INFLUENCES

Discussion has been directed primarily toward internal controls. Although at any given time management may believe that its functions and its action are predominantly internal, it should be acknowledged that every decision or every activity may have associated external repercussions. Trivial internal details sometimes become magnified to produce substantial problems created by external pressure.

Management, as late as the turn of the century, took the position that it had the right to enforce standards of its own choice in the operations of its own enterprise. It may even be said that the institution of private property by definition included such rights. Also, it may even be that as we proceed to resolve some of the social conflicts of the past half century, we will be forced to the conclusion that vested rights rest upon the ultimate authority in defining standards.

In any case, current history reveals the extent to which group pressures, arising out of grievances against selected management practices, have promoted the crystallization of public opinion to such an extent that we now find the assumed right to define some of our own policy and operating standards seriously limited. The limitation becomes evident in the form of restrictive legislation or perhaps in the coalition of aggrieved groups for the imposition of economic sanctions or threats against the offender.

During the past four decades, and more particularly during the past two, groups external to management and affected by management's action have become vocal. Group organization has grown and is in the process of growing at a rate not readily appreciated by management. Through regulatory legislation, groups have imposed upon management standards which management did not or would not adopt voluntarily.

The force of group pressure becomes more apparent when we assemble the mass of human beings external to the business unit according to their respective functional interest in the unit being administered. At the time a pertinent problem occurs in the usual business enterprise, management faces the demands and standards of customers, of creditors, of competitors, labor, government, stockholders and the general public. Each of these groups may be subdivided if more detailed classification promises to reveal more significant information which points more sharply to the standards and the conflict of standards within the major functional groups. Creditors, for example, may be broken down into commercial banks, investment banks and brokers, merchandise creditors, and others with special claims against the assets. The general public may be subdivided by sex, by racial characteristics, by religious affiliation, by ages, or, for example, by expressed positions on particular issues.

If management could detect, define, and communicate the standards of these groups to its own organization and feel that the job had been done, there might be some comfort around the corner.

The fact is, however, that standards are always changing. The demands of labor, for example, are generally different today from what they were three or six months ago. So with the demands of customers, of creditors, of government. Here is the broad area of public relations extending far beyond the range of simple "publicity."

The most elusive skills in management are those prerequisite to the selection of the appropriate standard for comparison at a given time and to the detection of the need for changes in standard as well as to the reconciliation of those that are in apparent conflict.

MANAGEMENT MEASURED BY ITS STANDARDS

The skill of management, then, rests upon the use of adequate standards. They must be defensible before the bar of public opinion or they provoke regulatory legislation.

By this reasoning, government control appears predominantly in those functional areas in which the masses have suffered or expected to suffer maximum grievance. Wherever and whenever the masses felt justified in restricting action by management they have insisted through democratic processes upon the use of law to compel management's acceptance of standards dictated by the masses.

By this reasoning, government control has not appeared in those functional areas where management has been meeting mass standards.

In the latter case we say that management is regulating itself. A more precise meaning of self-regulation then is voluntary adherence to mass or group standards.

It would be careless at this point not to anticipate the serious question: Does this mean that private enterprise is destined to keep adjusting itself always to the temporary and inconsistent whims of the public? The answer is a sharp negative.

We need to observe more than we do the influences which create mass standards. If we find them intolerable, and if we have a good case, we need to engage in positive compaigns to "educate" the masses to weigh the alternative offered by us. Here is a neglected activity. While management, representing capital alone, has been confining its energies to the protection of the rights of capital, friends of the masses have won their confidence and organized them to assert their own standards.

The issues over the designation of those best qualified to judge performance become academic; for finally, the choices and votes of affected external groups determine the standards of management.

Progressive management, then, is sensitive to the standards demanded by groups at interest. It recognizes that failure to effect compromises acceptable to groups at interest may bring increased government control; and it recognizes that insistence upon the use of one's own standards rests upon the ability of management to convert groups at interest to the acceptance of those standards.

We must conform to the requirement of public opinion, or we must educate the public to prefer our standards.

SUMMARY

A concise summary, with great respect for language, may be helpful:

1 Management cloaked with specific authority, derived from a source originating in law, is responsible for the direction of human effort in the pursuit of well-defined aims.

2 An organization of human beings performs the functions necessary to achieve those aims; but it is limited by policy and system prescribed to produce coherence as a unit.

3 Control, based upon adequate definition of standards by management, reveals problems.

4 Decision by management estimates causes and provides remedial action.

5 But aims and policies as standards are determined not by management, but by the public, and are changing.

6 Regulatory legislation is the imposition upon management of standards which management did not accept voluntarily.

7 Management's course then becomes clearly a choice: (*a*) Accept public standards, or (*b*) oppose them and submit to legislative control, or (*c*) convert the public to the acceptance of management's standards.

Professional practitioners like engineers and physicians are surprised to discover that they are already skilled in these techniques. They need mainly to add the art of discrimination in selecting appropriate standards from a varying assortment. Scientific methods have not yet provided enduring bases for judgment in estimating human emotions. We still need alertness in clinical experimentation; we need to manage our own minds, preserving an inexhaustible sense of humor.

The Education *of* Professional Students *for* Citizenship

(*Continued from page 962*)

they are to contribute valuable and enduring benefits. It is especially harmful if the integrity of a humanistic or social field is warped in order to make it apply to superficial technical problems. If English composition is degraded to teaching such topics as "business correspondence" and "report writing," for example, it becomes a trade course which regiments thought, cramps originality, and ceases to be a subject of college level at all. On the contrary, so to teach English composition as to relate it to the fundamental functions English should perform in clarifying and cultivating the student's scholarly, social, and professional thinking, and in communicating this thought to others, is to teach it at a high level and to increase the basic discipline which the course imparts.

Similarly, in teaching history, psychology, or economics, to give the subject relevance in relation to the student's profession, if properly and fundamentally done with care to keep the professional subordinate to the teaching of the subject, likewise does not impair but strengthens the integrity of the humanistic or social discipline and the quality of the teaching. For a lawyer to learn something of the significance and character of the legal and constitutional factors in history, for example, or for an engineer to learn the part played by engineers and technology in promoting the progress and creating the problems of civilization throughout the ages, not only exercises a significant cultivating influence on the student's professional outlook and work, but enhances the cultural value of historical education. Certainly in this age, when all men devote by far their greatest interests and energies to their lifework, if a man is not cultivated in his understanding of his profession and his practice of it, he is little likely to be so in anything else. The joinder of the social and cultural with the technical in a well-rounded professional education is the essence of preparation for citizenship and cultivated living.[9]

CONCLUSION

Let me review the reasons why this is so. If humanistic and social education is to be adequate preparation for citizenship and cultivated living, it must attain, through fundamentally the same methods that have given professional education its vitality and usefulness, vitality and usefulness as a basis for further learning and for problem-solving. If the humanistic and social education of professional students is to be truly cultural and social, it must play an important part in making their lifework cultivated and socially valuable. If it is to be an enduring and vigorous force in their professionally predominated lives, it must so unite professional ability and the ability to deal with human and social problems that growth in professional stature involves growth in personal and social stature.

Only if this is accomplished can humanistic and social education serve to make the student's life as a professional man increase his resonance and ability to respond to social, human, and spiritual values, whether they occur in his work, in his home, or in his community. Only if this is accomplished can technical education be lifted to the truly professional level. Only the joinder of humanistic and technical education in method and content so as to constitute a well-rounded and integrated professional education can bring this about. The responsibility of preparing professional students for effective citizenship and cultivated living is thus a responsibility of professional education that it cannot wholly delegate to general education.

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[9] Provost Buck of Harvard, in the address previously cited,[1] states "The democratization of society by making all men free citizens, means that the two kinds of education, 'liberal' and 'practical,' once given separately to different classes, must be given together to all alike."

STYLING *and the* MECHANICAL DESIGNER

By EARL D. HAY

IOWA STATE COLLEGE, AMES, IOWA. MEMBER ASME

DURING the past twenty years volumes have been written to make the public aware of the appearance of the machines and equipment which it uses. This publicity was made to pay its first large dividends during the depression in business in the early thirties when manufacturers were grasping for any and all kinds of straws to stimulate sales. At that time a few talented commercial artists with a keen knowledge of advertising and salesmanship were able to sell several prominent manufacturers the idea that by improving the appearance of their products sales would immediately increase. The increase in profits which followed, and which could at least partially be attributed to the improvement in appearance, led these and competing manufacturers to "go all out" for this new concept of sales appeal and to spend money lavishly upon anyone with the proper sales talk who gave himself the proper title.

These self-styled industrial designers were often given free rein in the plant, and the members of the design department were either ignored or called upon to work as lackey boys for the big boy who spoke in high-sounding phrases but was found to know little or nothing of engineering or mechanical design. However, the remuneration of the industrial designer was often 100 times that of the chief designer in the plant and for what often seemed to be a minor tinkering with the completed design. At the beginning of the afore-mentioned period and for many years preceding it mechanical designers, as a group, had an aversion to anything which they considered "arty" and unuseful when compared with what they were designing which they considered practical and useful. They believed a machine was completely and adequately designed when it performed its functions properly, was easily serviced, and had a reasonable life expectancy. What more could be desired? One prominent designer was known to make his machines rough and ugly rather than pleasing in appearance, giving as an excuse his desire that his designs have a rugged appearance.

It was indeed unfortunate that the mechanical designers were not sensitive to the trend of the twenties and were not prepared to follow it.

TRADITIONAL BACKGROUND OF DRAFTSMAN ARTISTIC

From a study of history we learn that the first designers of structures grew up in the tradition of art, having been apprentices to artists, sculptors, and painters. We like to point to Leonardo da Vinci as a classic example. The development of architectural structures and architecture as an art study progressed concurrently and the two were considered inseparable. This idea persisted until the present century. All early draftsmen were architectural draftsmen, trained in the drafting of architectural forms largely copied from those which had been developed in ancient Greece and Rome.

It is not surprising then to find that in the beginning of the machine age, which received its impetus from the development of the steam engine by Watt, and the engine lathe by Wilkinson, these early designers of machines had to employ as draftsmen and designers architectural draftsmen and designers as they were the only ones available. Such men, trained to think in terms of architectural forms and static loads only, naturally endeavored and persisted in interpreting machine designs in terms of the things they knew, architectural forms. Engine bases were embellished with Corinthian columns. Flat surfaces were ornamented with Grecian or Roman pilasters. Open spaces were filled with cast-iron vines. To these designers at the dawn of the machine age, art was the thing and the parts of a machine existed not so much for the function they were to perform but as a framework to be loaded or clothed with an antiquated art form.

A hundred years were to pass before Horatio Greenough and later Louis Sullivan were to express what the machine designers had been silently evolving through the years, "Form Follows Function." Hooke's law, strength, stiffness, and wear had emerged as basic factors in the design of a machine. Art form and decoration were receiving less and less attention.

History demonstrates the fact that basic ideas are of slow development and undergo cyclic motions like a huge pendulum possessed of great inertia swinging back and forth. They do not seem to follow a rational law but go past the mean from one extreme to the other. So it has been in the relation of art to mechanical design.

It was the mechanical designers probably more than the architectural designers who subconsciously developed the idea that form or shape is determined by function and size is determined by stress and stiffness and not by appearance.

It was the dawn of the age of steel which was forcing designers to seek new forms with which to express their structures in economical proportions. Yet while the designers were developing the new concepts of design in steel, art design and machine design were swinging further and further apart until at the close of the century all common ground seemed to have disappeared and the separation was complete. It was after the turn of the century that a few designers rediscovered the soundness of the ideas expressed by Greenough and Sullivan years before, that a good design will be both functionally and artistically satisfactory. Its beauty will be inherent in its functional form and not due to something added after the mechanical design has been completed. Contrast this idea with that in the birth of machine design when the architectural midwives clothed the members of the new machine with art forms which in most cases were as foreign to the function of the machine as barnacles on a ship's bottom and in addition were costly to produce.

It is not difficult to understand how such superficial plastered-on art became anathema to the mechanical designers. If such were art, they would have none of it. The development of the household machine, the automobile, and the airplane called for a new kind of machine designer, one akin to the present architectural engineer, basically an engineer, but also possessing a background of art principles and theory to

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the extent that he would be familiar with the basic concepts of art design or, might we say, of designing for appropriate form and pleasing appearance.

When a demand for a thing is created it will be supplied sooner or later from some source although not always from the best source. In this instance the demand for the new type of designer was met by the commercial artists who were sensitive to the new trend and not by the machine designers who had by far the best background of machine development and production. With the artist the prime consideration was bound to be form and appearance. Yet with clever advertising and sales ability they soon took over the field and demanded, and were paid, fees out of proportion to those paid the engineering designer.

In many manufacturing plants at the present time the final appearance of the machine is left to the stylist who is employed on a retainer-fee basis and who drops in every few months for a few hours to do his bit. In the meantime the progress of the designs is often delayed awaiting his appearance and decisions on what might be considered matters of minor importance; for example, making slight changes in the contour of the cowling on a line of farm tractors to give them more of a streamlined appearance.

This type of styling still gives the designer the impression that style is something to be tacked on and is not an integral part of the design and that the machine would work just as well without it. Basically this is not the modern conception of style or beauty. If the machine is reduced to its simplest functional form, it is conceded it will present a more pleasing appearance than in a less simplified arrangement of parts. Likewise the most pleasing shapes of the members of the machine will be those through which the functions of the machine will be performed with the best distribution of stresses and strains. The beauty of the human body is based upon the same principle.

If the foregoing statements are conceded to be true, then, it seems, the mechanical designer with a knowledge of art theory would be in a better position to do an acceptable job of styling, conceding basic style is built on form, than the artist whose only opportunity is to secure beauty by adding something to the functional machine. The machine designer can at least keep art theory in mind as he works out the combination of elements in the machine as a whole.

SOME BASIC ELEMENTS OF ART THEORY

Let us next consider some of the basic elements of art theory or styling which will be useful to the designer of machines and household equipment in improving their appearance as he works up his designs on the drafting board.

The subject which should receive first consideration is basic form, the outline of the part or of the whole, whether a building, a piece of furniture, or a machine. To be pleasing to the eye the form of the parts should be properly related to the whole. The whole structure should be unified, all parts telling the same story, as it were. There should be a rhythm and balance and harmony of form, proportion, and color between the parts and the whole structure. Seldom if ever can all of these be perfectly achieved in one composition, but with an understanding of the principles involved one can more nearly achieve them than with no knowledge of the subject whatsoever.

In the general type of machine designed to perform a given function the parts are so shaped that they will transmit the forces and motions assigned to them with the least cost of material involved. This usually means designing the parts for minimum size. In designing this type of machine, which consists of little more than an assembly of skeleton links, little can be done toward improving the over-all form except through simplification of the mechanism. Oddly enough, the simplest mechanism which will accomplish the purpose for which the machine is designed will usually give the best impression or appearance.

When designing household equipment or machines in which an envelope conceals the working skeleton, the designer has an opportunity to improve the appearance of the machine by properly proportioning the shape of the envelope. With a little experimentation the designer will discover that some ratios of height to breadth of a rectangle will produce shapes which are satisfying and full of interest while other ratios are flat and without interest. One would hardly be satisfied with a refrigerator built on the lines of a grandfather's clock or the front doorstep.

The use of the golden rectangle whose long side is the root square of the short side or of the root-five rectangle will help keep the novice on the right track. A study of such books as Teague's "Design This Day," and Hambidge's "Elements of Dynamic Symmetry" will be of great assistance. A word of caution is in order. While one is modifying the form of the envelope it should be remembered that for truth of expression the outside should, in general, give a correct impression of the shape of the machine it conceals and should not contain a large vacant space not required in the functional operation of the machine just to produce an exterior of interesting shape. The design should express truth. If, as is often the case, the exterior surfaces are not in ideal proportions, they may be improved by breaking up the surfaces into areas of pleasing proportions by means of beads, incisions, or colors. For a study of form and space relationships the designer should read such texts as, "Industrial Design," by Van Doren, "Design This Day," by Teague, "Elements of Design," by Batchelder, and "Furniture Design," by Varnum.

OVERDOSE OF STREAMLINING

In the middle twenties, which was the period of intense development in electrical household equipment and also in the development of the commercial airplane, a new word was injected into common conversation, streamline.

In its true significance it describes the flow of a fluid about a moving body of smooth and proper shape, a continuous flow which is free of discontinuities and turbulence, and to the engineer it indicates a condition of low frictional resistance to movement in the fluid. It assumes great importance in motion at high speeds as the resistance to motion increases as the cube of the speed. Leonardo da Vinci came close to the discovery of the principle centuries ago. Van Doren states in his text, "Industrial Design," "Streamlining for reduction of air resistance had been studied long before the word itself was coined. It is said that Bessemer made some attempts to streamline railroad trains in England in 1850. In 1865, the year the Civil War came to a close, United States patent 49337 was issued to Samuel L. Calthrop, of Roxbury, Mass., for a streamlined train... In 1890 the Baltimore and Ohio experimented with streamlining on actual runs."

To shape the body moving through the fluid to secure the lowest proper resistance is called streamlining the object. This is functional streamlining. It is found in nature and there only where turbulent or nonstreamline flow will produce appreciable resistance to motion. Classical examples are the three-dimensional forms of fishes and birds.

At first through observation and by deduction and later by experimental investigation in wind tunnels and through mathematical analysis, scientists learned to use streamline forms for many high-speed applications such as projectiles, rockets, aircraft, railway trains, high-speed motorcars, ships, submarines, torpedoes, and the like. For high speeds it can be easily proved that the use of streamlined forms are justified even if the adaptation is acquired at considerable expense. By the use of such fish-shaped forms the fluid is made to flow in smooth streamlines around the body and the only resistance offered by the body is a skin resistance, while any other shape will cause a turbulent flow about the body creating a high resistance to motion.

To the engineering designer functional streamlining makes sense. With his slide rule and wind-tunnel test data at hand he can quite accurately calculate the resistance to motion or drag on a body of known shape for different speeds. With propulsive-power cost data at hand he can determine at what speed streamlining should receive considerations and how much money one can afford to spend on it at any speed.

In nature, streamline form is found only on bodies which move at high speed and hence those which will profit by this type of form. In bodies which travel at low or medium speeds nature ignores streamline form for other considerations which assume more vital importance.

Through the years artist designers in contrast with mechanical designers have come to associate streamline form with motion, and anything which pertained to motion must perforce be streamlined, whether there was any scientific reason for its application or not. This use of the word is called nonfunctional streamlining. Norman Bel Geddes was the first to dramatize it and to make the masses conscious of it. He applied his typical catfish form to all kinds of moving vehicles from the speediest to the slowest. He was soon followed by Raymond Loewy with his evolutionary designs for automobiles. If it moved, it must be streamlined whether there was an economical justification for it or not. Old Dobbin and the dog were in line for streamlined haircuts to increase their speed. Streamlining became a fad, and the resulting streamlining of medium-speed vehicles has been justified from the standard of popular appeal rather than in the reduction of operating costs. Everyone wants to ride the streamliner trains. They are a symbol of fast transportation. Thus Streamliner has become a symbol.

Of this nonfunctional form of streamlining, Van Doren states; "In well-nigh its most advanced and complicated form, it may be seen in the design of children's vehicles or 'Wheel Goods' as they are known in the trade, scooters, play automobiles, velocipedes, etc. Its use in this case is surely legitimate, even though air resistance is not a factor, because children like anything that enables them to imitate their elders. . It has also become common practice to put streamlined fenders reminiscent of the fairing of airplane landing-gear wheels, on small wheels used on movable equipment. . .even washing-machine casters."

Artist designers also observed that streamline forms, along with less obvious attributes, were always smooth, and change in outline was gradual and not abrupt or bumpy, so they began to use the term streamlining to mean the smoothing or rounding out of a shape without any connotation of or relation to motion. This is a nonfunctional use of the term which is misleading and unfortunate. Its use has developed into a fad. In their book, "Art and The Machine," the Cheneys say: "If, since 1933, the term has threatened to become an abomination by its ill-considered application to short fiction and false teeth, wastebaskets and underwear, that is only another of the evidences that we have superficial stylists eager to capitalize the new slogan and misapply the new idiom, and make of them a fad of the moment. There are always superficial stylists."

There is another basic idea related to streamlining which provides a useful tool for the artist designer. This idea is related to and grows out of the functional use of streamlining in which use it is always related to motion and primarily high-speed motion. Certain forms have become associated with this use, and so much so that when the average person sees one of these streamlined forms he associates motion and speed with it whether high speed is a function of the particular object or not. For example, the children's vehicle toys previously mentioned are streamlined to give the impression of great speed. It is a psychological subterfuge of the designer—speed by suggestion. If such streamline forms are used to the detriment of the function of the machine, their use cannot be justified. If their application does not interfere with the normal function of the machine, these forms would then fall into the same category as a surface decoration or embellishment applied for the purpose of securing additional sales appeal.

The greatly accelerated use of plastic moldings and metal stampings and drawings in recent years has given the designer an incentive to use the nonfunctional form of streamlining under all sorts of conditions. Such forms are well-suited for all kinds of die work whether used for plastic molding, die casting, or metal drawing because of their smooth sweeping curves.

STREAMLINING VERSUS STABILITY

In recent years we have had our attention called to streamlined buildings, homes, and furniture—streamlining applied to things which are not supposed to move but which are supposed to be firm and stable. Again, form should follow function. If the function demands stability and immobility, the feeling of motion should be absent from design. The form should give the feeling of rest and quietness. A lawn chair should have the appearance of stability rather than give one the feeling he should hold it down for fear it would take off down the street. In this type of use streamlining has reached a fad stage and cannot endure for long. It reminds one of an early definition of jazz in music in which it was designed to create a shock or surprise in music by taking the dignity and grandeur out of a dignified composition. So in design, by injecting the effect of motion in an object which one knows is as solid and stable as Gibraltar, by the use of the elements of streamline, a liveliness is secured by the element of surprise. Such a use may seem pleasing at first but from its effect one soon recovers and tires. It does not have enduring qualities. A good design will possess unity. All elements will tell the same story and accentuate the central theme of the composition. Three parts will not say go and the fourth say stop. (Can you imagine a streamlined shell on a turtle? By his shape he is a balanced composition and indicates no motion at all.) Anything which takes away the sense of stability will produce the sense of motion. Balance in a design produces stability. Anything then which destroys balance will produce the feeling of instability and motion. A running man is off balance. Also we associate motion with the passage of time. Anything rhythmic in character indicates a passage of time and likewise motion. A uniform rhythm will produce a feeling of steady motion; one with its principal lines vertical, more or less stability, while a rhythm whose principal lines lean forward denotes more movement and motion. All designers know inclined lettering on a drawing indicates motion and liveliness, while vertical lettering is more formal and stable. A rhythm whose principal lines fall forward will indicate an accelerated motion, while one whose principal lines tilt back more and more indicates a retarded motion. To produce the effect of very rapid motion the enclosing shells of machines are not only given rounded noses but are embellished on the surface with jagged lightning rhythms to produce the effect of greatly accelerated speed.

If rhythms of several forms can be applied to the object, the sense of speed is increased. The basic rhythm will be the rhythm of form or shape of the main envelope. To this theme may be added rhythms of embellishment such as ribs or beads in the stamping, color rhythms, texture rhythms, and the like. In his text on industrial design Van Doren gives a simple and interesting discussion of the development of elementary rhythms which designers will often find useful. Indeed, the designers will find a study of the different kinds of rhythms very fascinating—rhythms of lines, rhythms of areas, rhythms of shapes, rhythms of scale, rhythms of color, rhythms of textures and finishes. These rhythms may be studied individually and in compound form.

In designing machine housings and envelopes as well as the members of the machine mechanisms, remember this is an age of simplicity in design. The simpler the design the lower the cost of production. If the proportions are good and the effect is pleasing, why add embellishment which will complicate the design and increase the cost? If the designer is inclined to add bands, beads, or grooves for appearance's sake, he should critically examine his design with and without the ornamentation time and again to be sure the additions will increase the sale appeal of the article. The really great designer is one who can tell the most with the fewest lines and simplest shapes.

COLOR IN DESIGN

In designing a machine to perform a given function through the use of forces and motions, the designer has nothing to do with color. His attention is confined to stresses and strains and pressures. A black lever could be just as strong as a blue or red one. As soon as he completes his calculations and makes his mechanical drawings the machine designer is ready to turn his material over to the production department. He considers his job finished. The machine receives its color dress somewhere along the production line to meet the requirements of the sales department. It is usually with genuine surprise that the machine designer looks upon his creation in its bright coat of color as it comes from the production line. The picture of the machine which he carried in his mind while designing it was devoid of color. The average machine designer has a deeply rooted feeling that the final finish of the machine is beyond the boundaries of his field and in plants of any magnitude it is, but in the smaller plants he would find the reading of a few books on color and finishes would increase his usefulness and might pay dividends. "Finishing Metal Products," by Simonds and Bregman, "Selling With Color," by Birren, are books of this type.

The average machine designer probably entertains the idea that color selection is a highly developed art and a science in itself and connects its use to the artist's application of it in making paintings. He feels its intelligent use is beyond him, and if he expects to make artistic paintings he would probably be right. In the field of machine design the number of colors used on machines is small and their combinations few. The machine-designer's problem is a simple one compared to that encountered by the designer of fabrics and wallpaper. However, the problem is becoming more complicated every day as the number of metal finishes is rapidly increasing. In the early years of the automobile industry Henry Ford used a black japan finish on all metal parts of his cars. It was quickly and easily applied and offered good resistance to rust and weathering. The car of the present is found finished in lacquer in several color schemes with a considerable amount of nickel- and chromium-plated parts. Still, the number of colors used are very few.

In the large farm-machinery field it has been found that very few colors are required, principally red and green which stand exposure well and are relatively inexpensive. Very little decorative striping is used at present. Paint and lacquer finishes are applied rapidly with spray guns while striping must be applied by skilled craftsmen and is relatively expensive. Blue, yellow, and ivory have been tried on farm equipment but have not been well received. Blues fade when exposed to the sun. Yellow and ivory finishes show up badly after the finish has been nicked in spots in use and the black metal underneath shows through.

The machine designer needs to study the effects of the kinds of metal finishes, not only for their sales values but also for their effects on fatigue stresses, and as protective coatings which prevent corrosion and the resulting loss of strength and decrease in machine life. These effects often determine the final selection of the material used for a given machine part.

The stylist has learned not to count too much on his imagination. As long as he was dealing with two-dimensional surface decoration he did very well by making pictorial drawings of his finished product. However, when he began to style three-dimensional machines and cabinets he found the representation of the finished product by three-axis drawing methods left much to be desired. In recent years the architects and stylists are making more and more use of scale models to show all dimensional and color relations of the finished product. Airplane and automobile designers make full-scale mockups of their designs. Machine designers could also benefit by the experience of others and profit by using scale models of their designs and in this way eliminate many cases of interference which are often discovered at such a late date that their correction proves to be expensive.

CONCLUSION

What should the machine designer do about styling? Ignore it; turn his back to it like the hillbilly when he saw his first giraffe and said "by gum, there ain't no such animal;" or should he spend some time in learning the basic relations of lines, forms, and finishes in art theory which make them attractive or unattractive to the eye and be ready to talk intelligently and work co-operatively with the stylist in the large organization or do a better job of designing in the small office where his work must cover the whole field of design?

The author is convinced that the general field of styling is not beyond the comprehension of the real designer of machines. The true designer in any field is one possessed of creative ability. It is the same kind of ability whether used in writing a book, play, or musical composition, or in creating a new type of machine or work of art. The real designer will find a real satisfaction in advancing his knowledge in a kindred field of creative design which he will discover follows as simple and as fundamental and as intriguing laws as those in the compass of his specialty, machine design.

Experimental Helicopter

THE U. S. Air Force's two-place liaison helicopter, the XH-15, manufactured by Bell Aircraft Corporation, is undergoing flight tests at the contractor's Niagara Frontier plant.

The XH-15, whose bubblelike nose provides exceptional visibility, is designed for use as an observation airplane, for special photographic work, aerial inspection of power or communications lines, or regular liaison assignments.

The helicopter, which has a top speed of more than 100 mph, a service ceiling of 20,000 ft, and a combat radius of 100 miles, is powered by a Continental XO-470 275-hp engine. Its two-bladed rotor system has a diameter of 36 ft 10 in., and the overall length of the helicopter, including rotor, is 43 ft. The design gross weight is 2700 lb. Three of these experimental helicopters are on order.

USE *of a* TECHNICAL LIBRARY

By R. H. WHITFORD[1] and J. B. O'FARRELL[2]

TECHNOLOGY-PHYSICS-CHEMISTRY LIBRARY COLLEGE OF THE CITY OF NEW YORK

LARGE volume production of engineering literature is a development characteristic of the twentieth century. Scientific publications of wide variety are being issued so prolifically that even the most zealous reader can keep abreast of progress within but a narrow field. It is highly essential, therefore, to acquire familiarity with efficient search techniques, for the specialist today must not only know, but know how to find. Successful library research depends as much upon sensing which kind of publication is likely to yield the information sought, as upon consulting appropriate aids and indexes. Accordingly, this article will outline suitable procedures for locating data in the various forms of technical literature, such as books, serials, journals, government publications, and trade catalogues, each type being described from the standpoint of subject material content and its availability through skillful use of bibliographical tools.

BOOKS

Books are primarily useful as sources for well-established facts, information, and theories. In science and engineering they have virtually ceased to constitute the records of original research, their function today being to present a selective summary of the state of any art. They do not contain the latest work in the field, for, even at the time of publication, they may be as much as two to three years behind current practice.

According to purpose served, books may be divided into several classes, such as the following:

(*a*) *Engineering encyclopedias and handbooks* are intended to augment knowledge and to provide a convenient presentation of professional principles and data. They are compilations by specialists and accepted authorities in various fields, written in technical language for practicing engineers rather than laymen. They are most useful for ready reference to fundamentals and tabulated data.[3]

(*b*) *Dictionaries* usually yield little more than brief definitions of terms. Even special technical dictionaries (except those of encyclopedic type like Thorpe[3]) seldom add much to definitions of the same terms found in general unabridged Funk & Wagnalls or Webster volumes. Highly technical words, however, lie beyond the scope of the latter lexicons.

(*c*) *Undergraduate textbooks* comprise the largest group of publications in engineering. While useful for instruction, and frequently well-indexed for quick reference, they differ from each other largely in method of presentation. Obsolescence occurs at a high rate, and three to five years has been given as a fair estimate of their useful life. After that, most current books are either revised or supplanted by better ones.

(*d*) *Treatises* are often difficult to distinguish sharply from the more advanced textbooks, although there is a fundamental difference in their roles. While the textbook serves to introduce a subject, the treatise attempts to be a comprehensive and authoritative compilation. It is well-documented with references, and thus provides an excellent bibliographical approach to the subject up to the date of writing.

(*e*) *Bibliographies* are lists of titles and sources on a given subject. They may be issued as separate publications, as reference or footnote citations in a book or article, or as printed catalogues of specialized library collections. Furthermore, a bibliography may be selective or comprehensive within certain limits of time, subject, or nationality, chosen by the compiler. It may be annotated in varying degrees of fullness, and be arranged chronologically, alphabetically by author, or preferably by subject subdivision.

(*f*) *Special subject guides* are designed for beginners who lack familiarity with bibliographical tools, and for specialists having occasion to work outside their chosen fields. To date no comprehensive guide to American engineering literature has been published, although articles and books emphasizing one phase or another of the subject are available.[4]

Books are arranged in a library according to some definite plan so that those possessing more or less common characteristics are grouped together. We speak of this arrangement as a "classification scheme" of which the best known are the Dewey Decimal, Library of Congress, Universal Decimal Classification (UDC) (Dewey expansion), and Bliss systems. All of these involve some arrangement whereby a symbol, called a classification number, assigns each book to a definite "relative" location on the shelves of the library.

Card Catalogue. This serves as an index or guide to the books in a library just as the index of a book enables one to find what is contained therein. The catalogue frequently is a single file consisting of a list of the publications available, arranged by author, subject, and some titles, all in one alphabetical arrangement. In such a case it is known as a "dictionary card catalogue." Under an individual's name may be found those of his writings which the library possesses. Again, for each publication dealing with a specific subject, a card is placed in the catalogue under that subject heading, thus bringing together in one place all references dealing with that subject. Instead of a dictionary card catalogue some libraries have separate author and subject files, classified arrangements, etc. The latter, used at the Engineering Societies Library, comprise three files, i.e., (1) author, (2) index to the classification scheme, (3) classified subject index.

Catalogue cards are more or less standardized in form and amount of information given. Many libraries use printed

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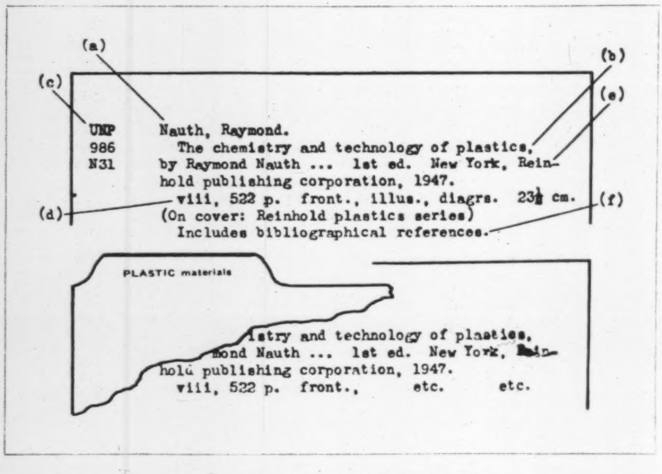
[1] Physics-Chemistry Librarian, C.C.N.Y. Associate ASME.

[2] Technology Librarian, C.C.N.Y.

[3] A few familiar examples are: "Handbook of Engineering Fundamentals," by O. W. Eshbach, John Wiley & Sons, Inc., New York, N. Y. 1936; "Mechanical Engineers' Handbook," by William Kent and R. T. Kent, eleventh edition, John Wiley & Sons, Inc., New York, N. Y., 1936–1938; "Dictionary of Applied Chemistry," by J. F. Thorpe and M. A. Whiteley, fourth edition, Longmans, Green & Co., London, England, and New York, N. Y., 1937—; "Civil Engineering Handbook," by L. C. Urquhart, second edition, McGraw-Hill Book Co., Inc., New York, N. Y., 1940.

NOTE: This article is a revision of the authors' series of four articles on engineering literature in *City College Vector*, vol. 12, nos 1–4, November, 1947–May, 1948.

[4] The following compilations will be found useful: "A Guide to the Literature of Chemistry," by E. J. Crane and A. M. Patterson, John Wiley & Sons, Inc., New York, N. Y., 1927; "Chemical Publications," by M. G. Mellon, second edition, McGraw-Hill Book Co., Inc., New York, N. Y., 1940; "Guide to the Literature of Mathematics and Physics Including Related Works on Engineering Science," by N. G. Parke, McGraw-Hill Book Co., Inc., New York, N. Y., 1947; "How to Find Metallurgical Information," by Richard Rimbach, The Author, Pittsburgh, Pa., 1936; and "Library Guide for the Chemist," by B. A. Soule, McGraw-Hill Book Co., Inc., New York, N. Y., 1938.



UNP Nauth, Raymond.
986 The chemistry and technology of plastics,
N31 by Raymond Nauth ... 1st ed. New York, Reinhold publishing corporation, 1947.
viii, 522 p. front., illus., diagrs. 23½ cm.
(On cover: Reinhold plastics series)
Includes bibliographical references.

PLASTIC materials
istry and technology of plastics,
mond Nauth ... 1st ed. New York, Rein-
hold publishing corporation, 1947.
viii, 522 p. front., etc. etc.

FIG. 1 STANDARD CATALOGUE CARD

cards issued by the Library of Congress, often in combination with typed cards illustrated in Fig. 1.

Each catalogue card, whether its heading is for author, title, or subject, furnishes part or all of such information as the following: (*a*) Author's full name; (*b*) title; (*c*) call number; (*d*) collation information; (*e*) imprint data; and (*f*) notes.

Use of a card catalogue comprising thousands of items is facilitated by familiarity with typical filing features, such as alphabetizing word by word (e.g., "electric motors" before "electricity"); disregarding initial articles; and grouping all variants of "Mac..." together.

Searching Book Literature. The following procedure is suggested for finding material on a given subject within books:

1 Check the card catalogue for books and bibliographies available in the local library. The subject groups of cards constitute a wide range of bibliographies of books immediately obtainable. Moreover, notes on particular cards, stating whether further references are cited in the corresponding books, are helpful and should not be overlooked.

2 Examine any bibliographies located by the foregoing means.

3 Consult comprehensive reference works such as handbooks, encyclopedias, treatises, and recent textbooks.

4 When more comprehensive coverage of the literature is desired, published bibliographical sources like the *Cumulative Book Index* and the *Bibliographic Index* may be used for ascertaining the existence of books in the field. These may then be consulted at other libraries, borrowed through interlibrary loan, or reproduced by microfilm or photostat, as later described.

PERIODICALS

In engineering and science, serial publications are perhaps the most important sources for locating technical information. The term is used to designate material issued in a continual series of parts, usually at regular intervals of time and under the same title. There are several prevalent types of serial publication, each serving a specific purpose. The research journal, like *Physical Review*, contains recent contributions to organized knowledge. Review serials (e.g., *Chemical Reviews*) present well-documented and critical summaries of the accomplishments within certain fields and periods. Transactions and proceedings of learned societies are the published reports of their meetings, such as papers read and the related discussion. Yearbooks may include statistical information, a register of the membership, and the constitution and by-laws of the issuing body. There remains a wide range of standard journals (*Engineering*), popular magazines (*Radio News*), house organs (*Du Pont Magazine*), and trade journals (*Iron Age*). The last-named are important sources for prices, production statistics, and reports on market conditions.

Serials are highly important media of communication because they contain accounts of current research activity long before the same material reaches book form. They can discuss subjects that are too limited in scope to warrant book treatment, and are the principal sources of information on questions of current interest.

Indexes. Thumbing through successive issues of journals to find topical material is usually time-consuming, except possibly when one recollects having seen it in a fairly definite location, when browsing for background information, or when all other search techniques have failed. Otherwise one adopts the more efficient procedure of consulting various indexes. Many periodicals issue an index to each bound volume, and sometimes a cumulative index for several years of a journal appears. More important, however, is the combined coverage of numerous selected journals by organized indexing services, such as the following:

(*a*) *Chemical Abstracts* represents the most comprehensive indexing service available to scientific research. While it ranks as the principal tool of chemists and chemical engineers, workers in other fields will find many of their familiar topics among its pages, for artificial subject barriers are disappearing, especially in this atomic era. It has been published since 1907 by the American Chemical Society, and current issues appear every 10th and 20th of the month, with contents grouped under 31 broad subject classifications such as metallurgy, petroleum, dyes, and textile chemistry. The intrinsic value of *Chemical Abstracts* as a research tool lies largely in the systematic use of its various indexes. Focusing attention on the most recent bound set on the library's shelves, we find that the last volume of the group is composed almost entirely of that year's author, subject, patent, and formula indexes. Number references therein are to columns rather than customary whole pages. The small superior digits (more recently letters) merely indicate how far down the page to look for the abstract in question. References preceded by capital P relate to patent abstracts. Preceding annual sets of *Chemical Abstracts* may be used in similar fashion until years included within the span of a decennial index are reached. At present writing three decennial indexes have appeared, and part of the fourth great compilation (1937–1946). Used together, they furnish convenient access to a veritable mountain of research data from both author and subject approaches. The list of journals searched by *Chemical Abstracts* is too voluminous (over 200 pages) to be duplicated in each volume as prefatory material. Accordingly, it should be remembered during the course of the present decade that the latest listing is to be found in the 1946 set.

(*b*) *Engineering Index*, much simpler in arrangement and form, dates back to 1884. Previously issued by the ASME, it is now published by Engineering Index, Inc., and selects items of engineering interest from over 1300 widely scattered journals. Most libraries purchase only the annual volume (received several months after year's end) because the associated weekly card service is rather expensive unless confined to narrow subject limits. Before 1919, a *classified* subject arrangement was employed; thereafter, a system of *alphabetical* bold-face headings, with subheads. Annual author indexes have appeared only since 1928. Each entry in *Engineering Index* includes an abstract, and appears under one solitary subject heading, linked with others by cross references.

(*c*) *Industrial Arts Index*, published since 1913, is comparable in value and utility with *Engineering Index*, for even though it analyzes only about 250 periodicals, it does so completely rather than selectively. Paper-covered issues appear every month, but half of these combine the contents of several prior issues within one subject alphabet. For example, the March number includes all entries for January through March, inclusive; in June a semiannual volume is published. A permanent bound volume replaces the whole series as soon after year's end as possible. This cumulative feature, which characterizes most H. W. Wilson Company library tools, enables one to examine very recent material while consulting a minimum of separate indexes. *Industrial Arts Index* is arranged alphabetically by subject only, with no author key. Entries lack abstracts, and may be duplicated under several subject headings.

(*d*) *Science Abstracts*, issued since 1898, under the sponsorship of both the English and American physical and electrical-engineering professional societies, has a novel two-part form: *A, Physics Abstracts; B, Electrical Engineering Abstracts*. Paired issues arrive monthly, eventually being bound in two separate volumes when annual author and subject indexes arrive. The present arrangement of entries in each thin issue follows the Universal Decimal Classification (UDC), outlined in the prefatory pages of each bound volume. Thus an engineer interested in hydroelectric power stations might turn each month during the current year to the entries labeled 621.311.21. Such UDC numbers should not be confused with the consecutive numbers assigned to successive abstracts throughout the year, to which the annual indexes refer. (*Science Abstracts* first adopted the UDC scheme in 1942. Prior to the transition year, 1941, some of the alphabetical subject indexes were semiclassified, and more detailed.)

(*e*) *Bibliographic Index*, another H. W. Wilson Company publication, began in 1938. It is "a quarterly subject index, with annual and five-year cumulations, to current bibliographies including those published separately as books and pamphlets, and those published as parts of books, pamphlets and periodical articles." While *Bibliographic Index* is broad in scope, it contains considerable material related to science and technology.

(*f*) *Other indexing media*, which cannot be fully described in this article, include *British Abstracts* (similar to *Chemical Abstracts*); *Monthly Abstract Bulletin* (photography, etc.); *Refrigeration Abstracts; Textile Technology Digest; Electronic Engineering Master Index; Applied Mechanics Reviews; Metallurgical Abstracts; Metals Review* (ASM); *Building Science Abstracts;* and *Bibliography of Rubber Literature* (published by *Rubber Age*); also shorter sections found in *American Ceramic Society Journal*, *Textile Institute Journal*, *Journal de Physique et le Radium*, *Wireless Engineer* (these abstracts appear later in the *Institute of Radio Engineers Proceedings*), *Aeronautical Engineering Review*, *Journal of the Iron and Steel Institute*, and other periodicals; finally, general indexing services, like *Readers' Guide*, *International Index*, etc.

Periodical Lists. Selected periodicals for various subject areas are listed in "Periodicals Directory," by C. F. Ulrich.[5] An entry for a journal includes year it began, frequency, price, publisher, periodical indexes which analyze it, etc.

"Union List of Serials in Libraries of the United States and Canada," by Winifred Gregory,[6] provides information concerning where sets of particular journals may be found. A symbol "NNC," for example, indicates that the Columbia University Library has a file, complete or as otherwise noted. Apart from this valuable union feature, this work constitutes an extremely comprehensive record of titles, changes and mergers, inclusive dates, cumulative indexes, etc.

The previously mentioned *Chemical Abstracts* (1946) list is extensive, and also shows location of periodical sets in various libraries by assigned key numbers.

The numerous journals listed in the prefatory pages of *Engineering Index* volumes are available at the Engineering Societies Library.

Lists of regularly published U. S. government journals appear in the January and July issues of the *Monthly Catalog*, later described.

Standard practice for alphabetizing periodicals is to file under corporate name if the title includes one; otherwise place under the first word of the title disregarding articles. The italicized words in the following cover titles will clarify this procedure: The Journal of the *American* Oil Chemists' Society; Transactions of the *Faraday* Society; *Journal* of Scientific Instruments; *Mechanical* Engineering; Journal of the *Society* of Motion Picture Engineers.

Searching Periodical Literature. "Background" and "backward" are the watchwords for making an efficient search for subject material within periodicals. The first connotes knowing enough about the topic to proceed intelligently, and involves the steps outlined under *Searching Book Literature*. Several recent journal articles should also be read to complete the orientation. The second implies that it is better to work from current volumes of indexes, etc., toward earlier ones rather than vice versa. This practice places initial emphasis on modern viewpoints before outmoded theories are encountered. Somewhere during the search a comprehensive authoritative review article may be discovered, which summarizes prior research adequately enough for the purpose. One may also stop when sufficient material has been gathered, or when the law of diminishing returns sets in.

Familiarity with systems of headings and cross references used in periodical indexes is of utmost importance. Several descriptive names may be applied to most subject entities. In order to avoid excessive duplication under all possible terms, a periodical index arbitrarily chooses one form as an active heading. The remainder, under which no article is ever listed, become "see" references and serve merely as signposts which guide searchers to the accepted heading. "See also" references, on the other hand, lead from one active heading which furnishes material to another equally active heading, providing additional data along related lines.

Before starting an extensive search in various periodical indexes, it is well to become familiar with relevant headings each has adopted. Unfortunately, choices are by no means standardized. For example, an article entitled "A Comparison of Some Elastic Properties of Tire Cords," by H. Wakeham, et al, *Journal of Applied Physics*, vol. 16, July, 1945, pp. 388–401, received differing treatment in several indexes as shown in Table 1.

Table 1 shows the wide range of headings under which entries or helpful cross references may be found. One should first prepare a list of all likely headings under which pertinent material is probably listed, including synonyms, antonyms, and related terms. Proceed systematically to look for suitable entries thereunder, taking advantage of the cross references furnished. If additional headings of fruitful character are discovered, add them to the original list for similar treatment. Record individual items of the bibliography on separate cards, being most careful to include full information. The following forms are useful standards to copy for general purposes.

Reference to a periodical article:

Reehl, E. A.—Specifying hydraulic fluids. Product Eng., 18: 122–125, Oct., 1947. (N.B.: "18: 122–125" means volume 18, pages 122–125 inclusive.)

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[5] Fifth edition, R. R. Bowker Co., New York, N. Y., 1947.

[6] Second edition, H. W. Wilson Co., New York, N. Y., 1941, and 1941–1943 supplement.

Reference to a book:

Dana, F. C. & Hillyard, L. R.—Engineering problems manual, 4th ed., N. Y., McGraw-Hill, 1947. 419 p.

TABLE 1 VARIETY OF HEADINGS ASSIGNED AN ARTICLE BY INDEXES

Possible Headings	*Industrial Arts Index*	*Engineering Index*	*Chemical Abstracts*	*Science Abstracts*
Automobile Tires	x	x	—	—
Cord	x	x	Art.	—
Elastic Moduli	—	—	—	Art.
Elasticity	Art.	—	Art.	x
Modulus of Elasticity	—	—	—	—
Rubber Products	—	x	—	—
Rubber Tires	—	Art.	x	—
Textile Fabrics	x	—	—	—
Textiles	—	—	x	Art.
Tire Fabrics	Art.	—	—	—
Tires	—	x	Art.	—
Tires, Automobile	x	—	—	—
Tires, Rubber	—	—	—	—
Tyres (Eng. spelling)	—	—	—	—

Key

x: indicates a cross reference which actually assisted in locating the article.
Art.: means that a specific entry for the article was found under this heading.
—: search not directly aided by this heading.

UNITED STATES GOVERNMENT PUBLICATIONS

An abundance of important reference information is available in government publications or "documents," which may be taken to include "any book, pamphlet, circular, or map issued by, or at the request of, a public agency and supported by public funds." They are usually issued in numbered sequence under such series designations as bulletins, circulars, technical papers, yearbooks, reports, etc. A great many are printed, but in recent years there has appeared an ever-increasing volume of "processed" material, i.e., publications which are reproduced by duplicating processes other than ordinary printing. The particular reproduction process employed is not necessarily a criterion of the relative value of information offered, as many research bureaus and laboratories utilize the more economical methods to stretch their limited printing budgets.

In both diversity of interest and number of titles the publications of the United States Government exceed those of any commercial publisher, and also any other government in all probability. Certain publications of the legislative and judicial branches are of possible scientific interest, such as the reports of a few Congressional hearings and investigations, and some issues of the important series entitled *House Documents* and *Senate Documents*. The executive branch, however, is the principal source for publications in science and engineering. It comprises nine departments under cabinet officers, three federal agencies of cabinet rank, and numerous independent offices and establishments. In addition, there are a few quasi-official agencies such as the National Research Council. Each department, agency, or independent establishment is subdivided into numerous bureaus, offices, administrations, centers, branches, etc. The Department of Commerce, for example, has fourteen divisions, among which are such important scientific agencies as the National Bureau of Standards, Weather Bureau, Bureau of Census, Coast and Geodetic Survey, Patent Office, and the Bureau of Foreign and Domestic Commerce. To keep informed of changes in organization and publication policy, one may consult the latest edition of the "United States Government Manual," as well as recent issues of the *Monthly Catalog*, described later.

As the Government is currently issuing over 20,000 titles yearly, the few examples listed herewith can at best be partially representative, but are grouped under the following five categories of information most useful to engineers and scientists:

(*a*) *Reports on research*, such as "Deterioration of Steels in the Synthesis of Ammonia," National Bureau of Standards, Technological Paper No. 361; "Preknock Vibrations in a Spark-Ignition Engine Cylinder as Revealed by High-Speed Photography," National Advisory Committee for Aeronautics, Report No. 785; "Headwaters Control and Use," Soil Conservation Service, 1936.

(*b*) *Laws and codes* dealing with conduct of business, type of construction, safety, etc., as "Code of Federal Regulations of the United States of America," National Archives, Division of the Federal Register; "Code for Protection Against Lightning," National Bureau of Standards, Handbook No. H 21.

(*c*) *Standards and specifications*, e.g., "Screw Thread Standards for Federal Service," National Bureau of Standards, Handbook No. H 28; "Asphalt Tile," National Bureau of Standards, Simplified Practice Recommendation No. R 225-47; "Federal Specifications for Receptacles (Convenience Outlets) and Connections," Federal Standard Stock Catalog, Section IV, W-R-151a.

(*d*) *Maps, surveying aids, and mathematical tables*, e.g., "Geological Atlas of U. S.—Raritan Folio, N. J.," Geological Survey; "American Ephemeris and Nautical Almanac," United States Naval Observatory; "Elliptic Functions Tables," Smithsonian Institution, Miscellaneous Publication No. 109.

(*e*) *Statistics* on business, production, imports, exports, prices, etc., in compilations like "Statistical Abstract of the United States," Bureau of Census; "Statistics of Electric Utilities in the United States," Federal Power Commission; "Biennial Census of Manufactures," Bureau of Census.

Government documents are fruitful sources of bibliographies, many of which appear as separate publications. Furthermore, most reports of research and testing have fairly comprehensive lists of references appended.

Indexes and Guides. Numerous guides and bibliographical aids to the use of government documents are available.[7]

To make readily available the information contained in this vast array of publications, various comprehensive and departmental indexes have been issued. Several, such as Poore's *Descriptive Catalog*, 1774–1881, and Ames' *Comprehensive Index*, 1881–1893, while very valuable to historians and certain other investigators, would be of service only on rare occasions to engineers concerned primarily with current developments. Accordingly, discussion will be limited to a selection of the more important aids covering contemporary publications of a scientific nature, like the following:

(*a*) *Document Catalog:* This was issued biennially from the 53rd Congress through the 76th, covering the period 1893 to 1940, but was discontinued by action of the Joint Committee on Printing in 1947. It was an analytical dictionary catalogue with entries under subjects, individual authors, and government departments. It not only superseded the *Monthly Catalog* (next paragraph) for the period covered, but in later years included publications and reports received too late for current listing therein.

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[7] "United States Government Publications," by A. M. Boyd, second edition, H. W. Wilson Co., New York, N. Y., 1941; "Government Document Bibliography in the United States and Elsewhere," by J. B. Childs, third edition, Government Printing Office, Washington, D. C., 1942; "Government Statistics for Business Use," by P. M. Hauser and W. R. Leonard, John Wiley & Sons, Inc., New York, N. Y., 1946; "Subject Guide to United States Government Publications," by H. S. Hirshberg and C. Melinat, American Library Association, Chicago, Ill., 1947; "Government Publications and Their Use," by L. F. Schmeckebier, second edition, Brookings Institution, Washington, D. C., 1939.

(*b*) *Monthly Catalog:* While published continuously since 1895 under various titles, only those numbers published since 1940 are of interest, previous volumes having been superseded by the *Document Catalog*. Until recently the *Monthly Catalog* was arranged by department, and agency under department, with an annual subject catch-title index. Beginning July, 1945, a monthly index was included, cumulating annually. Previously the investigator had to be thoroughly familiar with the organization of governmental bureaus and the scope of the publications which might be expected from each. Beginning September, 1947, upon recommendation of Jerome K. Wilcox, Chairman of the Public Documents Committee, American Library Association, some important changes have been introduced affecting its scope and arrangement. (1) The index furnishes more nearly a complete subject approach, rather than a catch-title listing. (2) The main body of each *Monthly Catalog*, formerly arranged by department, then component agency under department, is now arranged alphabetically according to the inverted names of the issuing agencies (e.g., Mines Bureau). Publications are then arranged under issuing agency alphabetically by title or series, all in one alphabet. Three supplements for the periods 1941–1942, 1943–1944, and 1945–1946 have been issued listing publications omitted from the *Monthly Catalog* for the same period either because of security reasons or previous policy. In the future, greater effort will be made to include processed publications and other non-Government Printing Office imprints, especially those issued by field agencies. Consideration is being given to the compilation of a cumulative index including all regular and supplementary issues of the *Monthly Catalog* for the period 1940-1947. This would be comparable with the decennial indexes of *Chemical Abstracts*, and should aid materially in locating information quickly.

(*c*) *List of Selected United States Government Publications for Sale by the Superintendent of Documents:* As the title implies, this is a highly selective list of new offerings, limited generally to those with broad popular appeal. It is published semimonthly, and is arranged alphabetically by subjects, with annotations and prices.

(*d*) *Price Lists:* For a number of special subject areas, price lists of publications which are still in print and on sale have been prepared. Because of such limitations, they obviously cannot serve as substitutes for the *Document* or *Monthly Catalogs*.

(*e*) *Checklists:* Many individual government agencies (including the National Bureau of Standards, Department of Agriculture, Geological Survey, Bureau of Mines, etc.) issue indexes and checklists of their own publications over a given period of time.

Patents. The United States Patent Office issues documents so highly specialized and of such fundamental importance to industry and engineering that they require special discussion. A patent permits an inventor to have exclusive rights to the development, sale, and assignment of his invention for a period of seventeen years in return for having disclosed his art, machine, or composition of matter in terms sufficiently clear to anyone skilled in the art.

Patent searching is a highly specialized vocation and requires proficiency in engineering, law, and patent-office practice.[8]

The principal publications of the United States Patent Office are as follows:

(*a*) *Patent Specifications:* These are complete descriptions of particular inventions, illustrated carefully by drawings and diagrams when necessary, together with inventors' claims concerning their contributions to the knowledge of mankind.

(*b*) *Official Gazette:* This abstract journal is issued every Tuesday. Patent summaries are arranged in numerical order, and furnish the title of the patent; name and address of the inventor, and his assignee; date of application; number of claims; classification number; usually but not always a drawing; and a highly technical abstract. The *Gazette* lists designs and trade-marks also. Each issue has various indexes to patentees and inventions arranged by catchword title. There is also a classified index to patents.

(*c*) *Annual Index:* This is compiled by cumulating the weekly lists of patentees and inventions. It is of relatively little use since it is arranged by catch title rather than subject, and there are very few cross references.

(*d*) *Manual of Classification; Decisions of the Commissioner:* These are primarily useful to patent attorneys and others needing this information in their daily practice.

Obtaining United States Government Publications. Inside the front cover of current issues of the *Monthly Catalog* are listed symbols used to designate the distribution and availability of federal publications. Items that are starred are available at the prices shown from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. (Only the semimonthly *List of Selected Publications* and *Price Lists* are issued free by that office.)

Where a single dagger is the distribution symbol, application should be made directly to the department or bureau issuing the document. Other symbols indicate when publications are not currently available or are printed for official use only.

Finally, a large black dot indicates those items distributed to "Depository Libraries." This designation characterizes over 500 depositories throughout the country which receive gratis single copies of documents with the understanding that they will preserve, bind, and make them accessible to the general public. The most recent list of names and locations of Depository Libraries may be found as a supplement to the *Monthly Catalog* for August, 1948. Most processed material is not included in depository distribution, but on the whole these libraries possess the most complete collections of documents outside Washington, D. C.

Although *Patent Specifications* are similarly excluded from depository distribution, they may be examined at some of the larger American libraries, such as the central branch of the New York Public Library, which maintains extensive files of both U. S. and foreign patents. Otherwise, individual copies of patents may be purchased from the Commissioner of Patents, Washington 25, D. C., at twenty-five cents each, or their summaries consulted in *Official Gazette* (regularly issued to depositories).

STATE AND MUNICIPAL PUBLICATIONS

These cover the same general areas as publications of the national government, but on a greatly reduced scale. Of interest to engineers are the following:

(*a*) *Reports on research*, usually emanating from engineering and agricultural experiment stations, or other departments of the state university.[9]

(*b*) *Laws and codes* concerning the licensing of architects, engineers, and certain skilled mechanics; health and safety;

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[8] Those wishing more details might start with a pamphlet entitled "Patent Background for Engineers," issued by Allis-Chalmers Manufacturing Co., Milwaukee, Wis., 1941; then advance to "Patent Notes for Engineers," by C. D. Tuska, *RCA Review*, Princeton, N. J., 1947; "The Law of Patents for Chemists," by Joseph Rossman, Inventors Publishing Co., Washington, D. C., 1932; and "Patent Office Practice," by A. R. McCrady, second edition, Pacot Publications, Madison, Wis., 1946.

[9] For example, "Mineral Engineering Research on Tin Ores in the United States," University of Kentucky, Engineering Experiment Station, Bulletin No. 3, March, 1947.

food handling and control, etc.; such as "Building Code," New York City, 1947.

(c) *Special engineering reports.*

(d) *State geological survey and mines bureau publications.*

(e) *Statistics*, principally social and financial.

Indexes and Guides. Because each agency of the several state and municipal governments generally serves as its own publication and distribution center, indexing and distribution are very unsystematic, and definitive coverage is impossible.

The publications of state agricultural experiment stations were abstracted comprehensively until December, 1946, by the *Experiment Station Record* issued monthly by the U. S. Department of Agriculture. (Bulletins of larger engineering experiment stations are indexed in *Engineering Index.*) The Library of Congress issues a *Monthly Checklist of State Publications.* It is arranged by states and includes only those publications received at the Library of Congress. A weekly index entitled *Bulletin of the Public Affairs Information Service* lists many state and municipal publications, but it is selective and limited to social and economic fields. Publications of New York City departments are listed regularly in the monthly *Municipal Reference Library Notes.*

For further discussion of state publications and their bibliographical aids, the reader should consult "Manual on the Use of State Publications," by J. K. Wilcox, American Library Association, Chicago, Ill., 1940, and the introduction to J. B. Childs' book on government-document bibliography, previously mentioned.

TRADE LITERATURE

Of great importance to engineers are the publications of trade and business organizations, for manufacturers' publications go far beyond listing specifications of products and equipment offered for sale. Many furnish comprehensive technical discussions of related engineering problems, such as design, application, installation, maintenance, etc. The compilers, who have firsthand knowledge of best current practice in their fields, present their data earlier and in greater detail than is possible in other media. The trend is also toward greater attractiveness of presentation. Descriptions and illustrations are frequently of such general excellence as to be useful teaching adjuncts.

Catalogues and Manuals. When turning to a catalogue for information, one should constantly bear in mind that it was issued for the purpose of selling a product. To fulfill this role most effectively it must be designed to capture the interest of the particular audience most likely to make purchases. This necessarily determines the type of information included. Accordingly, catalogues of consumer goods (automobiles, domestic heating equipment and appliances, etc.) are written in popular vein, emphasizing attractiveness and convenience of the products. On the other hand, catalogues of industrial equipment, engines, etc., are usually replete with performance charts, specifications, and application data in language familiar to engineers.

Catalogues, and instruction or service manuals, vary considerably in size, scope, and character. New Departure publications are good examples, chosen at random, of the wide variety of company offerings. There is an "Engineering Service" group of manuals on bearing application; details of design; enclosure and lubrication; bearing load computation; and application procedure. Comprehensive mathematical treatment appears in the two-volume set, "Analysis of Stresses and Deflections," 1946. New Departure "Handbooks" contain useful tables, data, formulas, and ball-bearing information. Other booklets cover maintenance and service, and there are many interesting brochures, e.g., "Why Anti-Friction Bearings?"

Also noteworthy is the extensive manual, "Instructions for Testing Electric Apparatus," issued by General Electric Company primarily for its embryo test engineers at Schenectady, N. Y.

Illustrative of the type of service booklet which describes special materials rather than fabricated products are the manuals of Rohm & Haas Company on Plexiglas, treating of its properties, fabrication, installation, etc.

Finally, economic aspects are dealt with in the annual reports of large corporations such as United States Steel's forty-sixth (1947) compilation.

Trade catalogues are commonly shelved alphabetically by name of company on library shelves. Firm and product card indexes are occasionally provided when library resources and conditions of heavy usage warrant. Otherwise, for a given product, one may consult directories, such as *Thomas' Register*, for manufacturers whose catalogues may be among the library's holdings.

Collective Catalogues and Directories. For reference to manufacturers and their products, selected catalogue material furnished by various individual firms appears in compilations like the following: *Aeronautical Engineering Catalog; Chemical Engineering Catalog; Mechanical Catalog* (ASME); *Metal Industries Catalog; Modern Packaging Encyclopedia; Modern Plastics Encyclopedia; Paper and Pulp Mill Catalog; Refinery Catalog; Sweet's Catalog Series* (for architecture, engineering, product design, mechanical industries, power plants, etc.). Space limitations naturally curtail the quantity of catalogue data which may appear for each concern. (Abundant textual and illustrative material is found in the packaging and plastics encyclopedias listed.) Certain journals, including *Chemical Industries, Electronics*, and *Oil, Paint and Drug Reporter*, publish similar product directories in the form of annual buyers' guides.

Thomas' Register of American Manufacturers is a most comprehensive directory, comprising several bulky volumes. The main arrangement is alphabetical by products; under each product, manufacturers are grouped geographically; then, under each city or town, firms are listed alphabetically. This main section is followed by an alphabetical listing of leading manufacturers giving their home and branch offices, subsidiaries, etc. An index of leading trade names is appended. Contractors, consultants, distributors, dealers, etc., are excluded, and must be sought in other directories, e.g., *Contractors' Register.*

Among organization directories may be cited the following: "Trade and Professional Associations of the United States," Department of Commerce, Industrial Series No. 3; "Industrial Research Laboratories of the United States," National Research Council; "Handbook of Scientific and Technical Societies and Institutions of the United States and Canada," National Research Council; "Classified Directory," Association of Consulting Chemists and Chemical Engineers.

House Organs. These are periodicals issued in the interest of a specific company or product. They are generally sent free of charge, and vary in size, frequency of publication, contents, and pretentiousness.

USING OTHER LIBRARIES AND SERVICES

For any single library collection to be complete would be a physical impossibility. When a sought item is unavailable at one's local library, it is usually procurable elsewhere, without too great difficulty, in original form or facsimile. One or more of the following procedures will ordinarily be found useful and effective.

Personal Visits. Apparently the simplest method is to visit a near-by library thought likely to possess the material in question. For journals, holdings may be ascertained in advance by consulting Gregory's list and certain others cited earlier under the heading "*Periodical Lists*." For books, etc., one considers the library's field of specialization and reputed richness of collection, aided by such compilations as "Special Libraries Directory," and "Special Library Resources," Special Libraries Association, New York, N. Y., 1941–1947, 4 volumes. Before traveling elsewhere, one should be certain he has not underestimated his own library's holdings.

Visitors must always be extremely careful not to abuse guest privileges. In general, most libraries willingly issue a reasonable number of books for reading-room use to patrons not among the clientèle for whom they are organized. Their staffs, however, cannot be expected to neglect major duties and obligations to these patrons in order to undertake lengthy searches for outsiders, beyond queries readily answerable from standard reference works. Because of heavily overtaxed facilities, some libraries have even been forced to curtail their welcome somewhat. The central reference department of the New York Public Library, for example, furnishes "Request Cards" which students from neighboring educational institutions are generally required to present when requesting service. No similar card system is in effect at the Engineering Societies Library, which is open to the general public for reasonable reference purposes, although primarily serving the needs of professional groups. Other libraries in New York of parallel interest include those associated with the Chemists' Club, Institute of the Aeronautical Sciences, and New York Academy of Medicine.

Interlibrary Loans. In case desired material should be unavailable within convenient traveling distance, one's local librarian possibly may be willing to borrow it from another library on interlibrary loan if circumstances warrant, according to the provisions of the "Interlibrary Loan Code."[10] Shipping expenses both ways are paid by the borrowing library, which is in turn reimbursed by the patron. In many instances it may be preferable to request photocopies instead of actual loans of material.

Reprints. The author of a periodical article may be willing to supply one of his reprint copies if it is available. (His address may be ascertained from the article heading, or from such biographical guides as *Who's Who in Engineering*, *American Men of Science*, and the annual membership rosters of professional societies.) If no reprints are available, perhaps the whole issue of the magazine may be purchased from a back-number dealer or the publisher. When these procedures fail, the following ones may yield results:

Photostats and Microfilms. At some library institutions, notably Engineering Societies Library, New York Public Library, and Columbia University Library, photocopying divisions stand ready to make approximately full-size photostats (paper) at a moderate charge per exposure. An alternative and less expensive method of photocopying employs strips of 35-mm film on which the pages successively appear in miniature. Each microfilm frame is clearly legible when viewed in a microfilm reading machine. Less conveniently, film strips may be deciphered by using an adequate pocket magnifier.

Photocopies of books and articles in library collections are obtainable from sources listed in "Directory of Microfilm Services in the United States and Canada,"[11] and from libraries designated by letter symbols in the *Chemical Abstracts* (1946) list of journals.

A national photocopying service extensively used is the Bibliofilm Service of the United States Department of Agriculture Library, Washington 25, D. C. Nine-inch-wide photostats are supplied as well as microfilms. Present order slips state that photoprints cost fifty cents for each five pages or fraction thereof from any single volume. Any periodical article in a single volume will be microfilmed for fifty cents; book material at fifty cents for each fifty pages or fraction thereof. This service is offered to all in so far as material within the library's extensive collection is concerned. In addition, qualified users of special coupons described in current *Chemical Abstracts* prefaces may obtain photocopies of virtually any technical paper which is available any place in the United States.

The American Documentation Institute, 1719 N Street, N. W., Washington 6, D. C., operates a quite different type of photocopying service. Co-operating journals publish condensed versions or summaries of certain important articles too long to be printed in full. An appended note states that the unabridged article may be obtained from American Documentation Institute. This organization will photograph the original document on 35-mm microfilm or 6 × 8-in. photostat paper whenever an order arrives.

Special Services. Engineering Societies Library (among others designated by appropriate symbol in the *Chemical Abstracts*, 1946, periodical list) will translate material in its collection. It also performs literature searches, and prepares bibliographies, abstracts, etc. Extensive services of this nature for chemical subjects are offered by the Kresge-Hooker Scientific Library, Wayne University, Detroit, Mich.

Fees are charged, of course, for all such special services rendered.

CONCLUSION

In concluding this article, may we emphasize our concern throughout with bibliographical *selectivity* rather than *inclusiveness*. While representative publications of diverse types have been cited to the extent that space permitted, attention was focused primarily upon basic library techniques and most important tools. Skill in unlocking the vast resources of technical literature is an asset to an engineer or scientist. Lacking it, he cannot know he is not needlessly duplicating past research, keep abreast of current activity in his field, or glean promising ideas for future development.

Having sketched the broad terrain and its main roads, we hope to have aroused reader wanderlust sufficiently to induce exploration of beckoning byways.

EARLY this year a committee was set up by the British Electrical and Allied Industries Research Association, under the chairmanship of T. G. N. Haldane, to investigate the possibilities of using wind power on a large scale for the generation of electricity.

According to a brief article in the Oct. 1, 1948, issue of *Engineering*, a considerable amount of work has been done already, including the collation of data, the initiation of experimental investigations based on preliminary studies, and the examination of proposals and suggestions received in connection with future investigations, so as to select those that are likely to be the most profitable. The committee was appointed to consider the technical and economical problems of large-scale aerodynamic power generation in Great Britain, including the collection of all available information and evidence, the principles of the selection of sites and the wind energy derivable therefrom, the co-ordination of wind-driven generators with supply systems, the essential design features of wind-driven generators, and the design problems which remain to be solved. At present, little use is made of wind power for generation in Britain, even in the northern and western coastal districts, where it is available in abundance during many months of the year, except for small electric-light installations in isolated premises.

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[10] *Library Journal*, vol. 65, Oct. 1, 1940, pp. 802–803.

[11] By J. G. Raymond, revised edition, Special Libraries Association, New York, N. Y., 1947.

ECPD ANNUAL MEETING

Continuing Education Discussed at Detroit

THE sixteenth annual meeting of the Engineers' Council for Professional Development was held in Detroit, Mich., on Oct. 29 and 30, 1948, at the headquarters of the Engineering Society of Detroit in the beautiful Rackham Building.

Friday morning was devoted to meetings of the Executive and other committees and to a meeting of the Council in executive session.

James W. Parker, chairman ECPD, and past-president ASME, presided at the luncheon on Friday noon which was addressed by H. P. Hammond, dean of engineering, Pennsylvania State College, member ASME, who spoke on "The Young Engineer—His Professional Growth and Development," a theme which was frequently stressed at all sessions of the Council. Dean Hammond's paper will be published in a later issue of this magazine.

At the general session of the Council which followed the luncheon the roll was called and visitors and guests introduced. Invitations had been sent to several hundred presidents and deans of engineering schools and colleges and a large representation was present. An effort had also been made to secure the attendance of engineering employers in the Detroit area in order to make use of the opportunity afforded by the holding of the meeting in that area to interest these men in the program and purposes of ECPD.

J. W. PARKER ELECTED CHAIRMAN

Officers of the Council for 1948–1949 were elected as follows: James W. Parker, chairman; H. S. Rogers, vice-chairman; S. L. Tyler, secretary; C. E. Davies, assistant secretary. Chairman of ECPD committees for 1948–1949 were appointed as follows: Committee on Student Selection and Guidance, Z. G. Deutsch; Committee on Engineering Schools, H. T. Heald; Committee on Professional Recognition, Ole Singstad; Committee on Information, F. J. Van Antwerpen.

Appointments to the Council, as nominated by the constituent societies named, were Frank Tolles, ASCE; C. E. Lawall, AIME; Guy R. Cowing, ASME (other ASME representatives are James W. Parker and R. L. Goetzenberger); M. S. Coover (reappointment) and M. D. Hooven (to fill the unexpired term of Everett S. Lee), AIEE; DeGaspe Beaubien (reappointment) and L. F. Grant (to fill the unexpired term of J. B. Challies), EIC; H. T. Heald (reappointment), NCSBEE.

The Executive Committee of ECPD for 1948–1949 will be constituted as follows: James W. Parker, chairman, Van Tuyl Boughton, C. E. Lawall, R. L. Goetzenberger, E. W. Davis, L. F. Grant, H. S. Rogers, A. B. Newman, and C. S. Crouse.

CHAIRMAN REPORTS AT ANNUAL DINNER

On Friday evening more than 100 members and guests attended the annual dinner of ECPD at the Hotel Statler. Mr. Parker presided and presented a resume of his annual report. This report will be published in a future issue of this magazine. It touches on the high points of the reports of the standing and special committees of ECPD which will be published in full by the Council at an early date, and it directs attention to areas in the field of ECPD activities which, in the opinion of the chairman, demand study, discussion, and appropriate action.

UNIFORM MEMBERSHIP GRADES PROPOSED

Reports of the ECPD committees were presented to the Council, in most cases by the chairmen of the committees, and were approved for printing in the annual report. Because the Committee on Professional Recognition made definite recommendations on uniform grades of membership and qualifications therefor for professional engineering societies, a subject long under discussion in ECPD, that portion of the report is quoted here.

> The Committee on Professional Recognition of ECPD has, for a long time, been engaged in a study of the subject, "Uniform membership grades and qualifications therefor for professional engineering societies."
>
> After exhaustive study the committee respectfully submits its unanimous recommendations:
>
> 1 That professional engineering societies adopt three essential grades of membership: Member, Associate Member, and Student Member. One or both of two additional grades of membership may be desired by some societies. The committee recommends that such grades be designated as: Fellow and Affiliate.
>
> 2 That professional engineering societies adopt the following minimum qualifications for uniform grades of membership:
>
> #### ESSENTIAL GRADES
>
> *Member:* A Member, at the time of his admission or advancement to that grade, shall:
>
> Be a graduate of an engineering curriculum approved by the governing board of the society involved, and shall in addition have had not less than four years of engineering experience of a character satisfactory to that board, at least two years of which shall be in responsible charge of engineering work.
>
> Or, if not such a graduate, he shall have had not less than ten years of engineering experience satisfactory to the governing board of the society involved. A license to practice professional engineering, issued by a legally authorized body, or the passing of an examination prescribed by the governing board of the engineering society involved may be accepted as qualifying experience.
>
> *Associate Member:* An Associate Member shall, at the time of his admission or advancement to that grade, be:
>
> A graduate from an engineering curriculum approved by the governing board of the society involved.
>
> Or, if not such a graduate, he shall have equivalent attainments, including at least four years of engineering experience of a character satisfactory to that governing board.
>
> He shall not remain in this grade after having attained the age of 32, at which time he must qualify for the grade of Member or Affiliate, or withdraw from membership.
>
> *Student Member:* A Student Member shall, at the time of admission to that grade, be registered as a junior, senior, or graduate student in an engineering curriculum approved by the governing board of the engineering society involved, and shall be pursuing a course of study in preparation for the engineering profession.
>
> The Student Member shall pay membership dues to the society.
>
> #### ADDITIONAL GRADES
>
> *Fellow:* The grade of Fellow shall have an honorary status to which an engineer of distinction is called, but for which he cannot apply.
>
> *Affiliate:* The grade of Affiliate shall apply to those who are not professional engineers but whose pursuits, scientific attainments, or practical experience qualify them to co-operate with engineers in the advancement of engineering knowledge and practice.

The report was approved by the Council and will be transmitted to the constituent societies with the suggestion that a conference be held at an early date for the purpose of discussing the recommendations.

ASME REPRESENTATIVES REPORT

Reports of the representatives of the constituent societies for 1947–1948 were presented on Saturday morning. These reports describe what each society has done during the year in those areas which relate to the field of interest of ECPD. The brief report of the ASME representatives, Ralph L. Goetzenberger, James W. Parker, and D. Robert Yarnall, is quoted as follows:

> In March of 1948 the Society held its second conference of representatives of the specialized societies in the mechanical field. At that time there was some extended discussion of the accrediting program of ECPD and as a result the view was expressed that succeeding meetings of the same character should be held and more time should be devoted to the entire program of ECPD. This annual dinner is a method developed by the Society to bring the other societies into close touch with the operations of ECPD.
>
> When the list of accredited curricula was developed by ECPD, the Society adopted this list as the list of approved schools which would be considered in judging applicants' qualifications for membership and as the list of schools in which Student Branches would be established. The Society had Student Branches in several schools which had not been accredited and some period was allowed to permit the schools to bring up their standards to meet the qualifications required by ECPD accrediting program. During the coming year the period of grace will expire and the Society will face the need of withdrawing at least one Student Branch. A policy has been developed by which the Sections of the Society adjacent to schools that are not accredited give to the students of these schools some aid and support that will be useful to them after they enter active engineering practice.
>
> As was reported last year the Society has developed an active program to stimulate the interest of young engineering graduates in the Society. To aid in this program the Society will welcome the development of a more active postcollege training program under ECPD leadership.
>
> The Canons of Ethics developed by ECPD have been approved by the Council of the Society and the members are now balloting on a change in the Constitution which will permit the embodiment of the Canons of Ethics in the Constitution and By-Laws of the Society. This ballot will be canvassed November 9. It is hoped that the membership will register approval of this change.
>
> The Society pledges its continuous co-operation and support to the ECPD program.

DR. A. G. RUTHVEN SPEAKS AT DINNER

The guest speaker at the annual dinner was Dr. A. G. Ruthven, president of the University of Michigan. Dr. Ruthven began his address by asserting that engineering education was being done well, that it could be improved, and that it would be improved. It had become increasingly apparent during the last quarter century, he said, that we were an uneducated people. Citizens must have information in order to govern themselves intelligently, he said, and education was a process by which men and women achieved their full stature as citizens. However, most adults were too much concerned with their own affairs to give much time to education of the youth. According to statistics that he quoted, of persons over 25 years of age in 1940 in this country 2,800,000 had not completed a single year of schooling, 7,305,000 had not gone beyond the fourth year, and 25,897,953 had not advanced beyond the seventh and eighth grades. Only 3,500,000 persons had as much as four years at college. In so far as financial support of education was concerned, he reported that Soviet Russia and Great Britain paid more for education out of every tax dollar than the United States. In the United States, he said, large groups of people were being deprived of education and lacked opportunity to learn about the advances of knowledge and of social changes. Ignorance was a contributing factor to our world difficulties.

In the past 25 years, he declared, there had been many plans, projects, and experiments in adult education. Some of these had failed and some had been discontinued. Many had been successful. There was, he thought, a growing appreciation of the belief that education is a continuing process. Education in any line, to be worth while, he asserted, must be continuous. Hence colleges and universities were becoming involved in adult education and were assuming responsibility for the dissemination of knowledge among mature persons. Professional schools emphasized technical subjects. College graduates were prone to believe that the only postcollege learning necessary came from experience, but to learn by trial and error, rather than by precept, was, in his opinion, wasteful.

It was the duty of college graduates, he said, to continue their development as good citizens and to improve their services to society. A large proportion of professional people were uninformed about the world in which they live and about recent advances in their own fields. They were, he declared, less informed on world conditions than were the undergraduates, and many were out of date in their own fields five years after they left college. Opportunities for adult education should be provided for those in professional pursuits. This subject, he said, was receiving the attention of colleges and universities and should be a responsibility of employers also.

In the United States, according to Dr. Ruthven, the college graduate should be first a citizen and second a worker. Professional people had a tendency to rationalize their prejudices. As a privileged class they should be looked to for leadership, but leadership was possible only through continuing study. Freedom could not be protected by legislative actions, he asserted. Nor could it be protected by depriving citizens of educational opportunities. Democracy, he said, was possessed only by men with trained and disciplined minds.

Professional men should be encouraged, he said, and compelled to seek the advice of older men and their employers, and the colleges should be organized to meet the needs of these men.

As a postscript to his address Dr. Ruthven quoted from a book published by the Carnegie Institute of Technology, "Education for Professional Responsibility," which, he said, should be assigned reading. (Two chapters of this book have been published in MECHANICAL ENGINEERING; one in the November issue, pages 895–897, by H. S. Rogers, and another in this issue, pages 959–962, by Elliott Dunlap Smith. A third chapter, by Arthur T. Vanderbilt, will be published later.—EDITOR.)

S. M. DEAN REPORTS ON CIVIC AFFAIRS

At the luncheon on Saturday, S. M. Dean, president, Engineering Society of Detroit, gave a stimulating talk on the work and achievements of the ESD Civic Affairs Committee. A description of this commitee and its work, prepared by Mr. Dean, was published in MECHANICAL ENGINEERING, March, 1947, pages 193–196.

In introducing his subject Mr. Dean spoke of the hiatus in the life of the young engineer that occurs after graduation. In that phase of his career the young man was trying to establish a home, and himself in industry, he said, yet it was important to him that he should maintain the growth of his professional status. The situation which he faced would be improved, but for success it was necessary to stimulate his interest.

The professional engineer, said Mr. Dean, possessed mental honesty, a knowledge of techniques and methods to be used, objectivity, and the courage to discard a wished-for answer in favor of one provided by the facts of the case. He had learned to do something well, which gave him confidence; he had good

(*Continued on page 997*)

THE NEW LOOK IN ECONOMICS[1]

By E. CARY BROWN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

"ECONOMICS,"[2] states Professor Samuelson, "is written primarily as a textbook for those who will never take more than one or two semesters of economics but are interested in the subject as part of a general education. It aims at an understanding of the economic institutions and problems of American civilization in the middle of the twentieth century." (p. v) He has succeeded well in his task, and the book has rapidly become a best seller. While it was developed for use in the course in economic principles taken by all M.I.T. students in their junior year, many other universities have been quick to adopt it. This book, then, will become highly influential, representing the first economics for students who continue with the subject, and the beginning and end of economics study for the great majority.

Professor Samuelson brings to this book a solid record of achievement. His contributions to economic theory, culminating in the publication last year of his "Foundations of Economic Analysis," have earned him an international reputation of first rank. In 1947 he became the first recipient of the J. B. Clark medal, awarded by the American Economic Association to the outstanding American economist under forty. When these abilities are combined with those of elaboration of ideas in a sprightly fashion, so amply demonstrated in "Economics," it is little wonder that the book has received such an enthusiastic reception.

"Economics" is divided into three parts: the first introducing the reader to economic concepts and institutions; the second to the factors influencing the level of national income and employment; and the third to the factors affecting the production and distribution of the output of fully employed resources. The introductory section, covering 11 chapters, discusses the central problems of any economic society, the nature and functioning of our present enterprise system, the institutions of our economic society—business, government, labor, and households—and the distribution and behavior of incomes as illuminated by recent economic data. In the discussion of business organizations is included a valuable appendix on the elements of accounting concepts and statements. The chapter on national income provides a convenient summing up of part I and leads easily into the second section of the book, the determination of national income. In this chapter the reader receives an admirable initiation into a field which has played an increasingly important role in the determination of economic policy in recent years. It is relatively easy to recognize the illiteracy of a stockholder who fails to understand the financial statements of a private concern. It is less obvious that a citizen who fails to understand the methods of economic accounting for the whole economy is also illiterate, but the consequences in this latter case may be more tragic than the former.

The heart of the book is found in part II—the analysis of the determinants of the level of national income and employment. This stems from the author's belief, shared by most economists, that "the first problem of modern economics" is understanding "the causes on the one hand of unemployment, overcapacity, and depression; and on the other of prosperity, full employment, and high standards of living." (p. 3) He adds that "full employment would not be characterized as such an important problem were it not for the fact that it is the one which has been 'acting up' most in our generation." (p. 15) This view is amply justified when we recall that the thirties were characterized by substantial unemployment in the economy and the forties by a pervasive inflation.

This part of economic analysis received an enormous impetus from the original work of the late Lord Keynes. Following the publication of his "General Theory" in 1936, bitter controversies were precipitated—controversies over his system as a *method* of analysis and those over the specific economic policies he advocated and the specific assumptions he made about economic behavior. The *method* of income analysis has now been widely accepted by economists, and demonstrated its worth both here and abroad during the wartime period. It has been refined substantially from the first formulation by Keynes, and will continue to be improved as more economic data become available for testing alternative hypotheses. It should be emphasized, moreover, that the use of the analysis does not commit one to any specific public-policy position regarding, for example, the role of Government in the postwar economy. In this sense, the analysis is neutral. It has been used by proponents and opponents of a specific economic policy, the differences in points of view reflecting different assumptions regarding economic behavior that are not yet susceptible to statistical testing. Nothing would be wider of the mark than the belief, held by some, that the answer income analysis gives to any economic problem is that public-works expenditures should be increased.

The major contribution of this type of analysis has been to free economists from the tyranny of Say's law. This law stated that supply created its own demand, that is to say, that the income resulting from the production of goods and services is always spent on goods and services. The circular flow of income is thus maintained, and general unemployment cannot arise except as a temporary phenomenon. In contrast, the essence of modern income analysis is a study of the level of effective demand for goods and services in the whole economy at different levels of output and employment. The demand for goods and services is made up of the amounts that income recipients are willing to spend on consumption goods, the amounts business firms are willing to spend on net increases in inventories and capital equipment, and the amount the Government is willing to spend on goods and services. If these amounts add up to more goods than the economy can produce, demand will exceed the supply available at full employment and prices will rise, as during the war and postwar inflationary period. If on the other hand total effective demand falls short of the full-employment supply of goods and services, business firms will not be able to sell all the goods they produce and output will be contracted. This contraction will continue until an equilibrium is reached—at which point the amount of spending at a lowered level of output is just sufficient to purchase that output. This equilibrium may fall considerably short of full employment.

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[1] One of a series of reviews of current economic literature affecting Engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Economics: *An Introductory Analysis*," by Paul A. Samuelson, McGraw-Hill Book Co., Inc., New York, 1948.

Samuelson emphasizes that our present knowledge of consumption expenditures shows that they depend primarily on the level of income, and are thus a largely passive factor. Investment expenditures, on the other hand, seem to depend on unpredictable factors, such as changes in technology, the level of income, the degree of business optimism, population, and the like. Historically they have been highly variable, giving rise to sharp fluctuations in output and employment. If investment drops, unemployment will result, unless other expenditures increase to fill the gap. If it rises to high levels, price inflation ensues, unless steps are taken to reduce total expenditures.

Total expenditures may be influenced by direct Government action, through taxation and expenditure policies which change consumption and investment outlays, or indirect action may be taken, e.g., by modifying interest rates through action of the Federal Reserve Board, or through legislation designed to reduce uncertainties of business and individuals. Samuelson does not believe an all-wise Government can settle all our economic problems. He does accept, however, the responsibility of the Federal Government to act as a balance wheel in the economy—a responsibility enacted into law by the Employment Act of 1946.

One area in which Governmental action has been taken in the past has been through control of the money supply and of interest rates. The mechanics of the money supply, central-banking technique, and their effect on interest rates and prices are covered in three chapters. Samuelson's pessimism regarding the efficacy of these methods to control economic activity reflects the modern belief that changes in interest rates, unless of such drastic magnitude as almost to rule themselves out, have but little influence on business investment expenditures or consumer outlays. Economists have therefore turned more and more to the taxing and spending policy of the Government—fiscal policy—as a more powerful weapon.

Samuelson makes a careful appraisal of fiscal policy, warning the reader that this subject is still controversial, particularly its use for a long period of time to raise the average level of effective demand if insufficient to keep the economy fully employed. He presents the arguments made by the leader of the school which believes that the economy in the future is very likely to be in such a position, Professor Hansen of Harvard University; and the leader of the opposition, George Terborgh of the Machinery and Allied Products Institute. Without taking a position on the question, he emphasizes the need for understanding those policies required by a stagnating economy and those required by one where inflationary pressures are strong.

The fiscal-policy issues are of three sorts.

1 Should the Government spend more on goods and services when unemployment threatens, or should it, instead, reduce taxes to stimulate private consumption and investment? If inflation threatens, should Government expenditures be reduced, or, rather, should taxes be raised to decrease private spending? Samuelson emphasizes that the use of taxation as against expenditures cannot be settled on economic or financial grounds, but are questions of social priorities—how people value Government goods and services as compared with private consumption and investment. Either method can influence the level of employment to the desired extent.[3]

2 The second set of questions involves the public debt. If budget deficits are incurred in order to sustain the level of spending in the economy, the public debt will increase. Can such a debt burden be sustained? Samuelson concludes "that the national debt does not yet constitute a problem of the first magnitude" (p. 432) after an analysis of the effects of public-debt holdings on the desire of people to spend more on consumption, the inhibition of central-bank policy by a large public debt, and the effects on incentives of taxing to pay the interest charges. These costs are placed in perspective by his emphasis on the fact, often forgotten in this discussion, that the national income of the United States will be an ever-growing one through increasing population, technology, and capital resources.

3 The third set of questions has to do with the possibility of maintaining full employment without a perpetual spiraling upward of prices and wages. These increases may take place long before full employment has been achieved and make impossible its attainment without drastic inflation. Some economists, notably Lord Beveridge, take the position that the difficulty is so great as to necessitate price controls. The author is not that pessimistic, rejecting this solution as one involving too high a degree of planning. Nevertheless he believes that "it is hardly too much to say that this price-wage question is the biggest unsolved economic question of our time" (p. 436).

The final section of the book deals with the traditional questions of economic analysis—the pricing and output of fully-employed factors of production, consumer behavior, foreign trade and tariff problems, speculation and risk, and social movements. The reader will, I believe, welcome the compression of this part of economics in an introductory treatment. Many a good man has bogged down in the more traditional economics and never gone further in the subject.

In a review of this size, only a few of the vast array of topics covered in this book can be touched on. They are dealt with no less carefully than those mentioned here. The reader will find this significant book an illuminating and entertaining introduction to a subject of increasing importance to the citizen.

ECPD Annual Meeting

(*Continued from page 995*)

sense and judgment; and he had the "amateur point of view" in civic matters. He was, by the late C. F. Hirshfeld's definition, a "scientific businessman."

The average citizen's predicament, Mr. Dean pointed out, lay in the fact that he read contradictory statements on public matters and had lost confidence in the validity of such statements. What was needed was a "lobby for the people." The place of the engineer in the discussion of public affairs was not to give more technical advice but to define situations clearly and authoritatively. Engineers, in his opinion, "have what it takes" to aid the decisions of the average citizen on civic questions. They had no axe to grind; they thought in factual terms; they provided straightforward answers; and they put facts together. It was hard to get them to run for political office, and as a minority they lacked the prestige of numbers. However, the Engineering Society of Detroit had among its membership a wide variety of abilities, knew the local situation, and had a stake in it, and through its Civic Affairs Committee it had rendered valuable service to the community.

The remainder of Mr. Dean's talk recited examples of what the Civic Affairs Committee had accomplished and included mention of many subjects in which engineers were vitally concerned and could be of service to their fellow citizens by discussing. He concluded by reminding his hearers that engineers had an opportunity to take a real and important place in the national economy and also an obligation to do it.—G.A.S.

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[3] He would emphatically deny, however, as would all reputable economists, that inflationary pressures can be reduced by giving people, through tax reduction, more purchasing power. The Alice-in-Wonderland reasoning in support of the tax reduction of this year is startling evidence of the need for public understanding of these issues.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Design for Environment

IN an address which he presented during the 1948 ASME Aviation Division Conference, Dayton, Ohio, S. R. Brentnall, Brigadier General, USAF, deputy director of research and development, Air Materiél Command, Wright Field, Dayton, Ohio, emphasized that the problem of "Design for Environment" is to design equipment to withstand temperatures of +160 to —65 F.

He pointed out that in the torrid belt of the earth two main classes of "hot" trouble are encountered—the dry heat usually found in the desert, and the humid-wet heat of the tropical jungle.

In the dry-heat areas, in the past war, cockpit temperatures as high as 180 F were recorded. This environment was an arid heat with of course the accompanying dust and sand of the desert. These fine abrasives of the desert were our worst material enemies, according to General Brentnall. Various kinds of dust were analyzed and five troublesome classes were found. These were dusts from the common dust storm, salt dust, lava dust, coral dust, and quartz. These dusts are found worldwide. In various parts of the United States these same dusts are encountered but not in the quantities found overseas.

General Brentnall said that to him the two most unusual were lava dust and salt dust. Lava dust, as the name implies, comes from volcanoes. When a volcano erupts, the heat is sufficient to produce glass if siliceous rock is present. These particles of fine glass are a strong abrasive in a propeller blast. Imagine 200 bombers taking off from the desert, each airplane with four propellers. These must take off as nearly simultaneously as possible to have them reach the target and return. The propeller blast is terrific. Knowing that air-borne abrasives can remove protective paint in a matter of seconds, one can readily understand what happens to the material.

The other unusual dust is salt dust. It is a far more insidious agent for destruction than the other dusts. Its origin can be traced to breaking waves, the salt mist being carried inland by the prevailing wind. The following is an example of how far one may expect salt dust to be carried: At Sambhar Lake, 500 miles inland in Central India, an accumulation of mined salt beds can be ascribed to salt arriving by air. The Southwest monsoons bring annually 30,000 to 40,000 tons of salt to this area by air, despite the accompanying heavy rainfall. Therefore, it is pointed out, an airdrome 500 miles from the ocean under certain conditions is not exempt from the effects of salt dust. Salt, as is known, is one of the best corrosive agents. Corrosion of exposed aircraft parts is definitely excessive in areas where such dusts occur.

General Brentnall then discussed the humid-wet problem of the Southwest Pacific area. There high temperatures are coupled with high humidities. Tropical deterioration starts as soon as material is placed on the tropical beachheads. Any cellulosic material is susceptible to decay by attack of fungus unless properly treated by a preserving fungicide. Leather goods, tentage, clothing, wiring insulation, paper, cellophane—all are subject to immediate attack. One of the most common complaints of the Armed Forces was against the use of pins, needles, or wire staples in clothing. Wherever there was contact between cloth and metal, moisture condensed, the metal corroded, fungi grew on the cloth, and a general mass of rust and rotten fabric was the result. He added that we cannot hope to dehumidify the tropical belt of the earth but we can hope to find better methods of preserving material by preventing fungus growth and corrosion. These preventative measures must be design criteria when starting on the drawing board.

In discussing the other extreme, the "cold" side, General Brentnall pointed out that inland in Alaska, in the winter season, temperatures as low as —83 F have been experienced. Trying to operate aircraft at that temperature is quite a problem. It should be borne in mind that at about —50 F the Eskimos go indoors and at —55 F the polar bear gives up, and —83 F is 30 deg colder. At —83 F oil becomes like cold tar, trim tabs freeze, tires take a permanent set so that one side stays flat until sufficient taxiing generates enough heat within the tire to let the flat side expand to its normal contour, control cable tension goes haywire, air-operated instruments freeze, the breath of the pilot puts a coating of ice on the inside of the

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

windshield, and fuel won't properly vaporize fast enough to start the engine. In addition to these mechanical troubles, the personnel are so cold that 50 per cent of their effort must go to keeping their own lubrication systems from freezing. These extremes are given for background to the cold-environment design problem. Various cures have been tried but the design indicator always points back to heat as the answer. The design, then, of any equipment must allow for the application of direct heat. Applied heat may take the form of external heaters, built-in heating elements, or heated shelters. If external heaters are used, it does reduce weight in the aircraft but adds to the maintenance load of having ground heating equipment to maintain, in addition to the aircraft. If the heating elements are built in, the aircraft weight goes up. If neither are done and heated shelters or hangars are built instead, the problem of mobility of such bulky items must be solved. The problem therefore is still open to solution and better answers are needed.

Besides the need for design against the elements there is another and perhaps more interesting design requirement, that of designing for usage.

An example of this is the C-82 Fairchild Packet. When the original specifications for this airplane were laid down, a requirement to land this airplane in unprepared soft fields or sand was not visualized. Therefore when this requirement arose, various methods to reduce the footprint pressure were investigated.

A result of one study was the track-tread landing gear. (See MECHANICAL ENGINEERING, August, 1948, p. 686.) The gear itself applies a simple continuous-belt and bogie principle. However, adopting the track gear injects the immediate problem of complete retraction to prevent loss of speed. The gear, being more bulky, requires more space to house it and in these days of thin wings, space is an expensive commodity. Loss of space, a possible decrease in speed, an increase in weight—all are parts of the price that must be paid for design for usage.

Bituminous Coal

A COMPLETE new data book about coal entitled, "Bituminous Coal Facts and Figures," illustrated with graphs, pictograms, and photographs, and printed in three colors, has recently been published by The Bituminous Coal Institute, Public Relations Department of the National Coal Association, and is said to be the most complete ready-reference handbook on coal ever issued.

The 1948 edition contains up-to-date information on bituminous-coal reserves, production, distribution, consumption, mechanization, man power, and many other subjects. It is a 148-page volume of graphs, illustrations, statistics, tables, and text. The present-day progressiveness of the industry is emphasized.

According to the new book, bituminous-coal mining in the United States is an industry of 7500 mines of commercial size which are located in 28 states and Alaska and managed by more than 5000 operating companies. The value of its physical plant is over $4,000,000,000. In 1947 the gross value of the coal produced at the mines approximated $2,760,000,000. The 1947 production of 620,000,000 net tons was a record which slightly exceeded the wartime 1944 output, yet by no means did it represent the industry's full productive capacity which is substantially greater. The major limiting factor is the number of railroad coal cars and other transport facilities.

The annual wage bill exceeds $1,500,000,000 a year, and some $500,000,000 is paid out annually for supplies, equipment, and repairs. The mining labor force of about 400,000 men averaged 6.3 tons per man-day, or more than five times the productivity of the British coal miner working by traditional methods. The mechanized productivity of American bituminous-coal mining is shown by the fact that in 1947 some 240,000 fewer miners produced 51,000,000 more tons than in 1920. This increasing electromechanization is a significant phase of coal's technological revolution. There is no coal labor shortage and by ages nearly half of the 400,000 miners are under 41 and 70 per cent are under 50 years old.

It is stated that Government authorities estimate that coal and lignite compose more than 98 per cent of the U. S. mineral-fuel energy reserves (including coal, petroleum, and natural gas, but excluding atomic power elements). Subbituminous and lignite exist in enormous quantities in western states, which has a vital significance to the future of synthetic gasoline and liquid fuels. In solid or liquid form this coal eventually will be called upon to satisfy enormous demands.

"Coal oil" is coming back in the form of synthetic petroleum made from coal and lignite, which exist in such enormity that Americans are assured of motor and fuel oils for centuries.

United States and world consuming needs for liquid fuels are expanding so phenomenally that the time is arriving for a new American industry in synthetic fuels to supplement natural petroleum. Government spokesmen advocate the creation now as a matter of strategic military preparedness, of a synthetic-fuels capacity of 2,000,000 bbl per day from coal, lignite, and oil shale. The oil industry probably devoted $10,000,000 in 1947 to synthetic-fuels research, and the U. S. Bureau of Mines is proceeding with its $60,000,000 research program and pilot-plant operations. The fact that two commercial plants to manufacture synthetic oil out of natural gas are under way imbues the American exhaustible resource of natural gas (primarily methane, or the gaseous phase of liquid petroleum) with a great new strategic significance, the book states.

It is also reported that early in 1949 the U. S. Bureau of Mines and Alabama Power Company plan to renew experimentation in gasifying coal in its underground seam without mining it.

The electric power and light utilities are among the most efficient users in extracting the utmost energy embodied in coal, the book points out. In 1947 the electric utilities consumed 86,000,000 tons of bituminous coal, as compared with 39,729,000 in 1929. By 1961 it is anticipated that 153,000,000 tons per year will be needed and more subsequently. By the end of 1948 this nation's installed generating capacity will reach 57,000,000 kw, yet electricity consumption is expanding so notably that predictions for an installed capacity of as high as 250,000,000 kw by 1977 have been made.

Immediate interest is centered on the gas turbine for railroad motive power, yet it is believed to offer a great potentiality for marine and for stationary power in the small and intermediate categories up to 20,000 kw. Some envision the day when a gas-turbine power plant can be located at a coal mine and its electricity output transmitted over distant lines to urban industrial markets.

The gas turbine burns oil, gas, and probably pulverized bituminous coal. If it burns pulverized coal—which coal men believe is indicated—it will have an abundantly inexpensive fuel in terms of heating energy per dollar of cost, important in the industrial East.

Reports and tables on tonnages, statistics on mechanization, figures on costs, prices, income, labor and investment outlay, as well as the text, were developed by the Institute. It is reported that the Institute will issue this handbook annually, in the fall of the year, with current statistical data and additional reference material, comparable to similar publications issued annually by the automobile, steel, oil, and other large industries.

Petroleum Research Center

MORE than 400 representatives of government, industry, science and education, and the press visited the new Esso Research Center, opened by the Standard Oil Development Company, central research affiliate of Standard Oil Company (New Jersey), at Linden, N. J., on October 14, the day designated by the American petroleum industry as Oil Progress Day.

PETROLEUM RESEARCH PROGRESS

In the opening day's ceremonies, E. V. Murphree, president of the development company, described the progress made by petroleum research over the past thirty years in the field of high-octane gasolines. He said that the compression ratios of spark-ignition engines will increase still further, and that the oil industry will be called upon to provide still higher-octane gasoline to operate those engines. In fact, one of the automobile manufacturers is planning to increase markedly the compression ratios of some of the makes of cars they manufacture, and it is likely that other car makers will do the same. (See "High-Compression Engine," MECHANICAL ENGINEERING, October, 1948, p. 822).

He pointed out that, to the automobile user, this change will mean better mileage for the same performance. An automobile with a compression ratio of 10 to 1, for example, should average about 30 per cent more miles per gallon than present 6.7-to-1 engines.

Of course a higher-octane gasoline is required for the 10-to-1 compression-ratio cars. It may be in the region of 97 or possibly higher. Petroleum research has developed the basic processes for producing gasoline of such a high octane number in large volume. Time and huge capital investments are required, however, to make such a large improvement in gasoline octane number. For this reason, increase in the compression ratio of automotive engines must not proceed at too rapid a rate and should be carried out in steps, according to Mr. Murphree.

He said it may seem curious that if the industry was able to make large amounts of 100-octane aviation gasoline during the last war, it should not have any difficulty making automobile gasoline of roughly the same octane. The volumes involved are, however, quite different. Mr. Murphree explained that at the end of the war, production of 100-octane aviation gasoline was about 500,000 B/D whereas present production of automotive gasolines is around 2,200,000 B/D which is over fourfold greater. Further, there is a very substantial requirement today for 100-octane and higher aviation gasoline. During the war, cost was no item whereas any large increase in the cost of automotive gasoline resulting from the higher octane number would eliminate any advantage to the consumer resulting from increased mileage. The cost to the consumer of the high-octane gasoline required by higher-compression engines must not be greatly different from that corresponding to gasoline of the octane level being marketed today.

He stated that it is our belief that a reasonable rate of increase in the compression ratio of automotive engines is basically sound. The companies associated with the Standard Oil Company (New Jersey) expect to provide gasoline that will meet our share of the needs of such a program.

Research in fuels for ultramodern jet-propelled aircraft, lubricants, industrial and specialty oils, modern processing methods for increasing the amount and performance of products refined from crude oil, and the rapidly expanding use of petroleum for new chemicals such as synthetic rubber and plastics, were also described by Mr. Murphree.

NEW PETROLEUM RESEARCH CENTER

The laboratory and office building of the new Esso research center, which was visited in the afternoon, is a modern three story structure consisting of a main wing 580 ft long and 60 ft wide, with three office wings, 70 × 42 ft. It accommodates 80 separate laboratories, 250 offices, and a library which is said to contain one of the most complete collections of petroleum technical information available in any industry.

An auditorium seating 150 persons has specially designed acoustic features that permit a normal speaking voice to be heard from any part of the room without amplification devices. Other unusual equipment includes facilities for tape recordings of speeches and wall panels that slide away to provide extensive blackboard space.

The new building is constructed of brick around a steel frame, and is functionally designed throughout to accommodate the exacting requirements of modern research. Movable metal partitions form the laboratory and office side walls so that each room can be altered in size to meet the requirements of the work being done in it. The entire building is air conditioned in such a way as to prevent accumulation of fumes and gases and contains the most modern safety devices.

The laboratories themselves are fully equipped for general research purposes, including alternating and direct currents, illuminating gas, compressed air, vacuum, nitrogen, chilled water, and steam. These services are supplied from a basement service section and are distributed to the laboratories through pipes and wires concealed in the corridor walls.

Seven hundred and fifty chemists, physicists, engineers, and service-department personnel will be engaged in this new center. Since industrial research is a team effort, the activities of the research center will be closely co-ordinated with the intensive research and pilot-plant work conducted at other laboratories of the development company and its affiliates.

Among the problems currently under active study and to

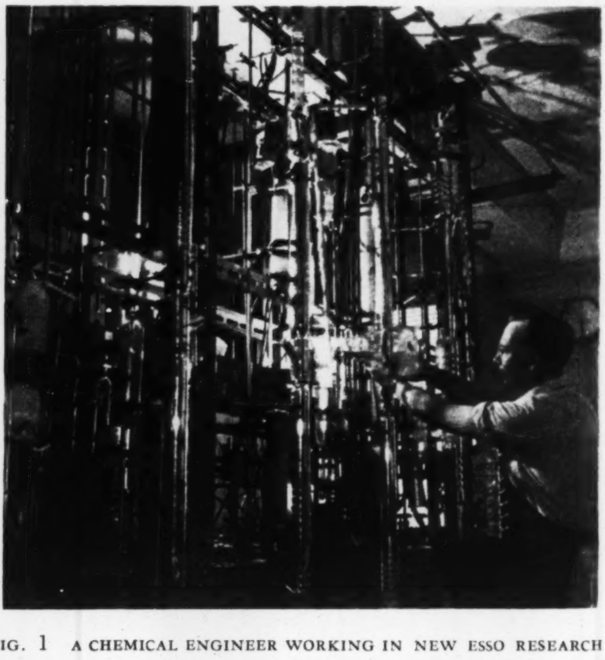

FIG. 1 A CHEMICAL ENGINEER WORKING IN NEW ESSO RESEARCH CENTER WITH CONTINUOUS DISTILLATION EQUIPMENT

(This is used for separating mixtures of liquids that have different boiling points into their pure individual components. These separation studies include the chemical by-products of the hydrocarbon-synthesis process, which is under development for making synthetic liquid fuel from natural gas and coal.)

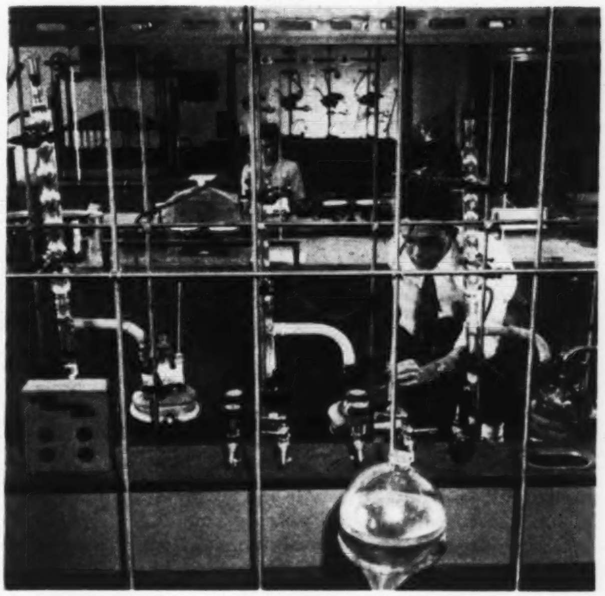

FIG. 2 THE ADDITIVES SECTION OF THE ESSO RESEARCH CENTER
(Additives are substances incorporated in oils to improve their performance under varying conditions, for example, to make oil remain liquid in cold weather.)

which the new facilities will contribute, are the conversion of natural gas and coal into liquid fuel, production of higher-octane automotive and aviation gasolines for the more efficient engines of the future, new lubricants, and many projects in the chemical field including extension of the quality and use of plastics.

Construction also is proceeding on a motor laboratory, a two-story, 60 × 199-ft structure. This laboratory will house 11 soundproof test cells, including one for aviation engines, and will accommodate 20 engines at one time. It is expected to be completed by the middle of 1949.

Besides a tour of inspection of the new research center, the program included two lectures, one on butyl rubber and the other on motor fuel oil.

ACADEMIC AND INDUSTRIAL RESEARCH

The relationship between academic and industrial research was the subject of an address given by Dr. Karl T. Compton, newly appointed chairman of the Research and Development Board of the United States National Military Establishment, and retiring president of Massachusetts Institute of Technology, at a dinner at the Waldorf-Astoria Hotel, New York, N. Y., closing the Esso Research Center dedication program.

Dr. Compton said that one thing which academic research and industrial research have in common is the fact that it took them both a long time to gain general acceptance as respectable elements in our society. The industrial research laboratory, being a later phenomenon, was later than the academic research laboratory to achieve this position of public acceptance, respect, and support. However, the basic ideas back of both of them are not new, and, ever since the Dark Ages, were advocated by men of great distinction.

Regarding the advisability of a young physicist or chemist taking a position in industrial research, Dr. Compton pointed out that in the early days there was a strong feeling that if such a move were made it was very unlikely that the scientist would ever again have an opportunity to get back into university research if he so desired. There was a sort of feeling that a scientist prostituted his scientific ideals if he descended from the ivory tower to tackle a line of work which would permit some people, and perhaps himself, to make some money. Undoubtedly, a generation ago that was one of the handicaps against which industrial research laboratories had to struggle in recruiting to their staffs men of top-notch scientific ability but it is fair to say that this situation no longer exists and that the industrial research worker is judged on the same basis as his academic brother, namely, by the caliber of his work.

Various factors have brought about this change. One is that the academic scientist has come to recognize the importance even to his own academic research of the contributions which have been made by the scientists and engineers of the industrial laboratories—contributions not only of tools and techniques but also of basic scientific discoveries. The second factor was the close collaboration between scientists of both groups in achieving their goals in research and development during World War II.

Dr. Compton also mentioned four environmental factors which he said were particularly important and whose increasing recognition by management is in no small degree responsible for the increased effectiveness of industrial research laboratories and for the attractiveness of positions in these laboratories to research workers. The four factors are time, stability, independence, and contacts.

According to Dr. Compton, industry has been more and more adopting the policy of giving direct support to academic research laboratories. Sometimes this is done by direct contracts on a quid pro quo basis, but more often it is by grants in support of a general line of research which the company believes will be beneficial to it because of a future gain in knowledge and training of research personnel in fields in which the company is vitally interested. This, said Dr. Compton, is an evidence of real industrial statesmanship.

In conclusion, Dr. Compton stated that we can confidently expect that in this new laboratory there will be made scientific discoveries and their application which will really lead us

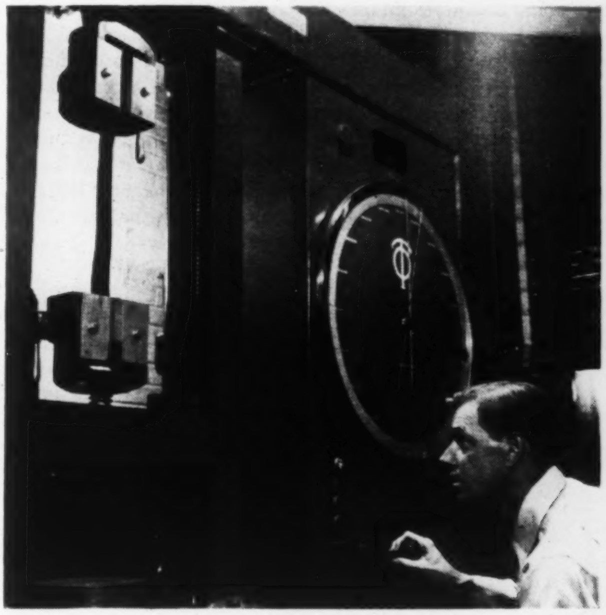

FIG. 3 IN THE RUBBER TESTING LABORATORY OF THE NEW RESEARCH CENTER A SAMPLE IS TESTED FOR TENSILE STRENGTH
(This particular sample is butyl-covered glass cloth, to be used as lining for an irrigation ditch.)

forward and aid in the ultimate triumph over ignorance and war.

New Gas Engine

ADAPTATION of Cooper-Bessemer's Turboflow development to the four-cycle gas engine, an improvement that is claimed to produce 14 per cent more power while cutting fuel costs by at least 20 per cent, has been announced by the company's engineering division.

The new Turboflow four-cycle engine will discard the standard fuel-mixing valve and utilize in its place a simple gas-injection system similar to that used on the company's atmospheric-gas-Diesel engines.

Company officials explained that prior to the new Turboflow development the four-cycle gas engine had been rated at 70 bmep and fuel consumption at the rate of 9500 Btu. In addition, exhaust temperatures have been reduced from 1000 to 850 F.

The significance of the new development, it was pointed out, is that in any area where natural gas is available at $1.10 or less for 1000 cu ft (which is the fuel-cost equivalent of current 14 cents per gal fuel oil) fuel-cost savings can be achieved.

Aircraft Engines

Turbo-Cyclone Compound Engine

THE range and power of America's military and commercial planes of the future will be increased by 20 per cent, it is claimed, as a result of the development of a new type of aircraft engine which Wright Aeronautical Corporation, of Wood Ridge, N. J., engine-building division of Curtiss-Wright Corporation, has announced it will put into quantity production for the U. S. Navy.

The new power plant, called the Wright Turbo-Cyclone 18 compound engine, combines a reciprocating engine with three turbines into a compact efficient unit which weighs less than one pound per horsepower developed. While information on its power output is a Navy secret, Wright engineers say it is the most powerful aircraft engine of its type in the world.

Tests conducted by the Wright Company indicate that a given aircraft powered with the new Turbo-Cyclone 18 compound engine can (1) operate 20 per cent farther for the same fuel consumption than it can if equipped with the conventional type, or (2) operate the same range with 20 per cent less fuel. In long-range aircraft where fuel load can amount to $2^{1}/_{2}$ times the pay load, this saving in fuel would provide an increase in pay load of as much as 50 per cent.

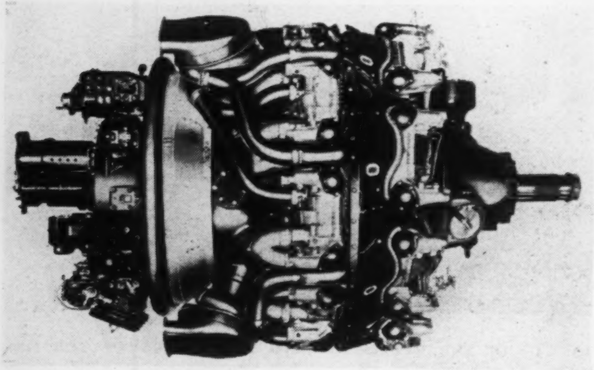

FIG. 4 SIDE VIEW OF NEW TURBO-CYCLONE 18 COMPOUND ENGINE

According to information approved by the U. S. Navy for publication, the new engine combines a reciprocating power plant with three "blowdown" or velocity turbines which operate on the exhaust gases to recover approximately 20 per cent of the available heat energy normally lost through the exhaust. Conversion of these gases into power which is geared back directly to the crankshaft, adds 20 per cent to the horsepower developed by the engine for the same fuel consumption.

To illustrate the newly designed compound engine's performance in terms of range, Wright engineers say that the U. S. Navy's far-flying Lockheed P2V patrol bomber, "Truculent Turtle," which is powered with Wright Cyclone 18 engines and which holds the world's nonstop record of 11,236 miles (made Oct. 1, 1946), could, if powered with the new Turbo-Cyclone 18 compound engines, have flown 20 per cent farther or 13,483 miles nonstop.

The same engineers point out that in the commercial air-transport field, airliners normally scheduled for a refueling stop during transcontinental and transoceanic flights, could, if powered with the newly designed compound engine, operate on nonstop schedules because of that power plant's reduced fuel consumption.

Aside from increasing the power, range, and pay-load capacity of existing military and commercial aircraft, the new power plant is said to have the following advantages: (1) It operates efficiently over a wide range from sea level to high altitude; (2) its turbines impose a minimum of back-pressure on the engine, and consequently do not impair the operation of the piston power plant or impose any additional stresses on piston-engine parts; (3) no additional controls are required. This means no special training of pilots or flight engineers is necessary in the transition from conventional power plants to the compound engine; (4) the new compound engine may be installed in existing aircraft because it is adapted to an existing power plant, increases the latter's over-all dimensions by only a few inches, and fits within the cowl lines of existing installation with a minimum of change; (5) its power-recovery units act as mufflers without cutting the output of the engine.

The first of the new compound engines will be installed in a new U. S. Navy airplane. No further details on the new power plant or the number to be produced, have been approved by the U. S. Navy for disclosure.

Piston-Jet Engine

An airplane engine which delivers more than 4000 hp to a propeller as well as several hundred pounds of jet thrust, is being developed for the U. S. Air Force by the Pratt & Whitney division of United Aircraft Corporation, East Hartford, Conn.

Known as the R-4360-VDT (Wasp Major-VDT), the new piston-jet-propulsion combination consists of a 28-cylinder Pratt & Whitney R-4360 (Wasp Major) engine and a two-stage General Electric variable-discharge turbosupercharger.

The VDT power plant is said to enable heavy, long-range aircraft to fly farther, faster, and higher. Airplanes can take off with heavier loads of cargo, fuel, or bombs, and they can climb faster. Bombers powered with the VDT can go into and away from target areas at high speeds and at altitudes of nearly eight miles.

First use of the VDT power plant will be in the Air Force's Boeing B-54, previously designated as the B-50C. This strategic bomber is to be an extended development both of the Boeing B-29 and of the newer B-50.

The efficiency of the new power-plant combination rests pri-

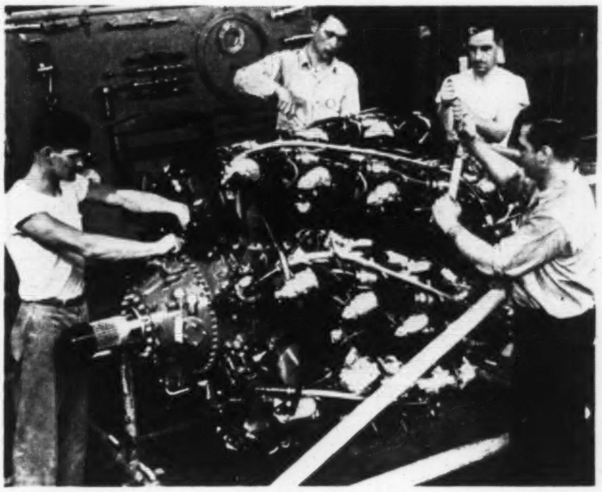

FIG. 5 U. S. AIR FORCE NEW PISTON-JET-PROPULSION ENGINE

marily in the effective use of the energy in the engine's exhaust gases, heretofore largely wasted, and in the aftercooling of the supercharged combustion air.

The General Electric CHM-2 two-stage turbosupercharger utilizes the engine's hot exhaust gases in two ways. The turbosupercharger first uses their energy to supercharge all combustion air required by the engine. It then discharges the gases to the rear through an orifice, the size of which is varied to obtain the best division of exhaust energy between supercharging and jet thrust. Thus the energy in the fuel is utilized to deliver power directly to a propeller shaft, to supercharge combustion air, or to create jet thrust.

In addition to the use of the variable-discharge turbine and the aftercooler, the R-4360-VDT is unique in other respects. The conventional throttle is used only for low-power operation. Engine power and speed, for the most part, are regulated automatically by controls which enlarge or restrict the variable-area-discharge nozzle. This determines the amount of exhaust energy extracted by the turbine for supercharging. The quantity of supercharged air delivered to the engine, in turn, fixes the power output of the R-4360. The elimination of throttling in the air-intake passageway reduces combustion-air entrance losses.

The fuel-injection system for the VDT is equipped with a fuel-injection pump developed by the Bendix Products Division of Bendix Aviation Corporation, the pump and the air-metering units being integral. Another division of Bendix, Scintilla Magneto, provides the low-tension ignition system for the engine.

Except that the R-4360 engine takes the place of the burners, the turbosupercharger has all the elements of a turbojet engine—air compressor, nozzle guide vanes, turbine rotor, tail pipe, and exhaust nozzle. After the air is compressed by the supercharger, instead of being mixed with fuel and ignited in the usual jet burners, it is fed into the 28 cylinders of the new engine. After fuel is injected and burned in this air inside the cylinders of the piston engine, it returns to the turbine in the form of hot exhaust gases. These gases are directed through the turbine rotor and discharged from the exhaust nozzle in the same fashion as in a jet engine. Unlike the conventional jet engine with its fixed-area discharge orifice, however, the area of the VDT discharge nozzle is varied automatically to eject gases at the most efficient discharge speed over a wide range of operating conditions.

The entire VDT power plant uses main elements and principles with which engineers have had a wealth of experience. Emphasis has been placed on making the entire power plant, its arrangement, and its individual units, as simple as possible. This factor is believed to have contributed to the satisfactory completion of an official 150-hr qualification test in August. The engine is currently being test-flown in a B-50.

While the external appearance of the new power plant is substantially the same as that of earlier models, many engine components have been made heavier and stronger to handle the increased power available at the propeller shaft on the VDT. Thus despite the elimination of the engine's internal supercharger and its driving mechanism, this additional metal, together with the fuel-injection system, has increased the weight of the engine. The increase in horsepower, however, has resulted in a decrease in the engine weight per horsepower.

Turboprop Engine

A new, powerful turboprop engine, the Wright T-35 (Typhoon), has been undergoing flight tests conducted by the Wright Aeronautical Corporation, Wood Ridge, N. J., as a part of the United States Air Force turbine development and test program. The engine, equipped with a Curtiss electric propeller with four blades, is mounted in the nose section of a Boeing B-17 Flying Fortress, resulting in a five-engine, high-altitude, flying laboratory.

The T-35, designed and developed by the Wright Company, has been subjected to numerous ground and flight tests, the results of which have not been announced.

The gas-turbine-propeller combination is not capable of turbojet engine speeds, but it is said to provide greater range than jets and in addition, has characteristics similar to the turbojet engine, particularly in high-altitutde flight, maximum efficiency at full power, mechanical simplicity, minimum vibration, and reduced engine frontal area. Turboprop development for aircraft has been hampered by the inability to control the propeller satisfactorily in relation to the high rotating speed of the engine under all flight conditions.

A considerable advantage in using the B-17 flying laboratory

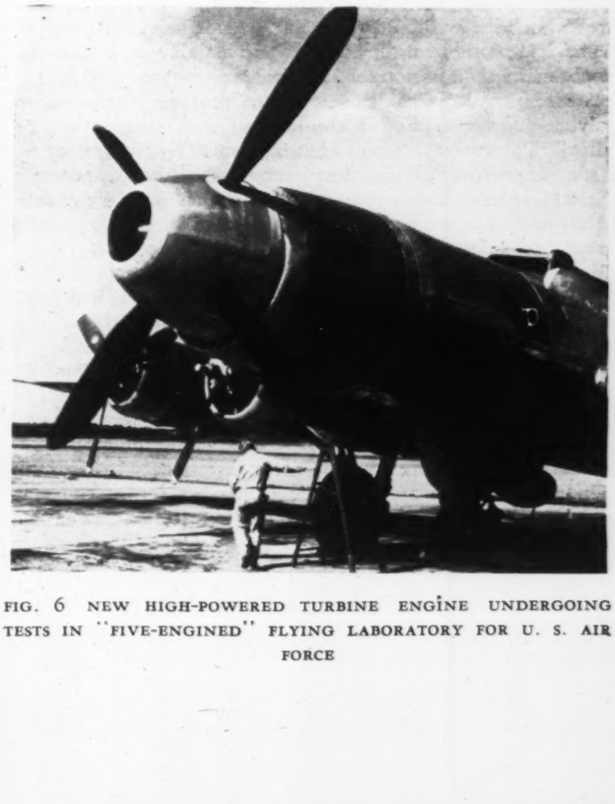

FIG. 6 NEW HIGH-POWERED TURBINE ENGINE UNDERGOING TESTS IN "FIVE-ENGINED" FLYING LABORATORY FOR U. S. AIR FORCE

for these tests is that the engine, propeller, and nacelle may be studied under actual flight conditions and at a cost considerably less than in methods normally used. Heretofore, the engine and nacelle were not tested together until the aircraft's initial flight test.

Considerable alteration was necessary on the B-17 to accommodate the added engine. The T-35 is mounted in the section formerly occupied by the bombardier. This necessitated moving the cockpit four feet to the rear, extending the nose section, and completely reinforcing the fuselage.

Flight tests have been conducted for more than a year by Wright's chief test pilot and crew at the company's Caldwell, N. J., airport.

Ceramic-Coated Molybdenum

THE lack of materials with the required properties for operating temperatures in excess of 1800 F has been a restrictive influence in the development of ramjets, pulsejets, turbojets, and rockets. The availability of materials suitable for use at higher temperatures than those in current use would effectively lessen design problems, making possible, for example, increased specific power in turbo engines. Because the requirements of stress and temperature for such increased performance are beyond the potentialities of the currently used high-temperature alloys, scientific investigations at the National Bureau of Standards, under the sponsorship of the National Advisory Committee for Aeronautics, have been directed toward the development of ceramic coatings for the metals having very high melting points, in order to protect them against oxidation at high operating temperatures. Preliminary results indicate that molybdenum with a specially designed ceramic coating offers a promising combination for very high-temperature service.

Most heat-resistant alloys begin to melt when heated within 2400 to 2600 F. Of the metals whose melting points greatly exceed this temperature range, only such scarce metals as platinum and iridium, melting at 3180 F and 4260 F respectively, have sufficient resistance to oxidation at high temperatures to be used without protection. Aside from the question of physical properties, the cost of these metals and the limited supply make their use on a large scale prohibitive.

The ceramic coatings developed to provide protection to molybdenum are applied in the form of water suspensions or "slips" to cleaned specimens of molybdenum by either dipping or spraying. After drying, the pieces are fired at a temperature of 2150 F in oxygen-free atmospheres. The furnace is the only special equipment needed beyond that normally used in applying ceramic coatings.

A number of coatings were prepared. Some of these were outstanding in resistance to thermal shock while others had good resistance to high temperatures. One of the better coatings, M-13-33, consisted of: (1) a base coat of a low-expansion frit with 20 per cent zirconia added; (2) a cover coat containing 95 per cent zirconia; and (3) a seal coat consisting of a thin application of the same composition as the base coat.

Coated specimens were subjected to several significant performance tests during the Bureau's investigations. These included heating in a gas-oxygen flame, heating at constant temperature in an air atmosphere, and service testing in the blast of ramjet engines.

The results of these various tests indicated that the oxidation of the molybdenum was greatly retarded by the best of the ceramic coatings tried. In an air atmosphere at 1650 F, unprotected molybdenum sheet was found to decrease 0.02 in. in thickness in $^1/_2$ hr. There was no decrease, however, for ceramic-coated molybdenum heated for 70 hr under the same conditions.

At a gas temperature approximating 3500 F, giving a surface temperature on the specimen of 2600 F or more, only short-time protection of the molybdenum was attained. The oxidation rate at these high temperatures was found, however, to be sufficiently retarded by the presence of the ceramic coating to make the use of coated molybdenum feasible for special high-temperature applications in which prolonged service is not required.

An immediate application of these ceramic coatings is the protection of molybdenum Pitot tubes which are built into the nozzle end of ramjet engines used for pilotless aircraft. These tubes, which are subjected to a gas temperature of about 3000 F, are expendable and need not last more than 5 min. A simulated service test of a ceramic-coated tube indicated a life in excess of 45 min.

In addition to Pitot tubes, other examples of equipment in which even short-time protection can be valuable include coated thermocouples and resistance thermometers made of high-melting-point metals.

Underwater Flow Photographs

A METHOD of taking underwater photographs that reveal the flow patterns about surface vessels has been developed by the Experimental Towing Tank Laboratory of Stevens Institute of Technology, according to a recent report. As a research tool, such photographs show promise of providing a valuable aid to the understanding of flow phenomena around a body. The method, similar to the "tuft" technique used in wind-tunnel and flight testing of aircraft, utilizes limp threads attached to the model itself, or to fine wires extending from it.

The report stated that the technique appears to have many advantages over other methods heretofore used. It is said that the method has not previously been applied to ship forms and other comparable bodies, and it should serve to increase the general understanding of flow conditions and interference effects.

Specifically, it can be employed in locating the optimum position of the rudder and the propeller, and such appendages as bilge keels, scoops, overflow pipes, and propeller struts or bossings. In addition, its application may also effect a reduction in the amount of repetitive testing required in steering and turning investigations.

Bilge keels are a kind of long fin installed one on each side of the bilge. Their purpose is to provide roll-damping of the ship in rough water, and it is important to locate them so they follow the natural line of flow. Propeller bossings, the housing that brings the propeller out from the hull, can be located most advantageously if the flow line is known.

The flow in the region of the rudder is studied so that it can be placed in the best location for steering. The study of the location of the propeller on the hull by this method will assure its most effective location, so that the flow of water to the propeller itself is unimpeded by obstructions.

Officials of the Towing Tank said that underwater flow photographs might also be useful in studies of the basic hull shape. Sharp corners and knuckles often introduce confused flow which adds to the resistance of the hull. Photographs will indicate such regions of confused flow and redesign of the hull shape may eliminate them.

The report, prepared by William H. Sutherland, Mem. ASME, project engineer at the laboratory, points out that a decided advantage of this method, in addition to its virtue of simplicity, is that it yields a picture of the simultaneous flow pattern over a wide area.

For the initial experiments, the threads, or tufts, were short lengths of black woolen yarn, glued into shallow holes in the surface of the model. The models were self-propelled with small electric motors and a battery drive. Propellers and rudders were built to exact scale, so the flow conditions would be similar to those of a full-sized ship. In the photographs, of course, the propeller does not appear to be moving since the camera "stops" it.

In order to obtain a view of the model hulls, the camera was mounted on the end of a waterproof wooden box, propped against the side of the tank, the side of the box forming a 45-deg angle with the bottom of the tank. The camera was focused on a front-coated mirror on the bottom of the box. The mirror was tipped so as to reflect, through a glass window on the side of the box, the underside of the hull of the model being tested. Two Kodatron flash unit lamps were placed, one on each side of the camera, in boxes similar to the one for the mirror.

Film used in the 5 × 7-in. view camera was Eastman Kodak Super Panchro Press Type B. An F 6.8 lens was used set for an exposure of $^{1}/_{200}$ sec. The length of the Kodatron light flash was approximately $^{1}/_{10{,}000}$ sec. A photoelectric cell operated the camera shutter and the lamps. The beam was reflected back from the carriage of the model by a mirror.

The report explained that this particular setup has an interesting property. Near the model, the angles made by the rays of light entering the camera are such that there is total reflection from the underside of the water surface. The camera cannot "see" objects above the water through the surface, and it sees some parts of the model twice—once directly and once reflected in the underside of the water surface.

Waste-Wood Utilization

SAWDUST and wood chips easily can be made back into usable forms of wood with the addition of only minor amounts of a plastics material, according to a talk given by Dr. Nicholas N. T. Samaras, research director for Monsanto Chemical Company's Plastics Division, at the Third National Plastics Exposition.

He revealed that the resulting pressed boards can be sawed, turned, and otherwise handled like wood. Also, the material has no grain and is therefore not subject to splitting. In weight, the product is essentially the same as the wood from which the sawdust comes, and is at least as strong as wood in its weakest direction, he pointed out.

In addition, Dr. Samaras reported that considerably better dimensional stability and water resistance can be expected because the plastic content acts not only as a binder but also improves the water resistance of the wood fibers themselves. It is a simple matter to apply paint or enamel to pressed wood panels and moldings. A sealing coat followed by an air-dry or baking-type enamel or lacquer results in a smooth grain-free surface. The finish is superior to that possible with wood because of the freedom from grain, he explained.

The wood chips or sawdust are mixed with between 5 and 15 per cent Resinox, one of Monsanto's industrial plastic resins, and other ingredients. The mixed resin and wood goes into a mold by means of a blower-hopper feed or vibrator. The mold is inserted into a press where heat ranging from 300 to 350 F, and pressures of less than 200 psi are supplied. Depending on the thickness of the structure, the mix stays in the press from 3 to 15 min and comes out in a completely finished piece.

Inasmuch as sawdust and wood chips are considered a waste material and are used mainly for fuel, the raw material for this process is very cheap, Dr. Samaras added. Figuring the waste at $5 a ton and the resin at 27 cents per lb the cost of the raw materials for the finished product is estimated to be about 3 cents per lb.

Some uses of this material are as follows: The flat panels could be used as core material faced with plywood for building purposes; for table tops surfaced with plastic decorative laminates; for counter tops; for flush and panel-type doors; and for use in the field of molded shapes.

Electronics Plant

PRECISION electronic equipment—vacuum tubes, varisters, thermisters, resistors, mercury switches—in process of manufacture, were shown to members of the press and other guests at the formal opening on October 13, by Western Electric Company, Inc., of its new electronics plant at Allentown, Pa.

The new plant is located on a 50-acre tract two miles east of the center of Allentown, under the supervision of Western Electric's Engineer of Plant. Its cost is said to be more than $10,000,000 and it will employ approximately 2500 men and women. Four principal buildings comprise the plant, namely, a main manufacturing building, a two-story office building, a utilities building, and a gas-generation building located some distance from the other units.

The main manufacturing building, which will house some 5000 machines, is a 450 × 375-ft two-story steel-frame structure. All service piping, duct work, and conduit is systematically arranged and suspended under the ceiling of the lower floor so that no drop piping is required from the main floor ceiling to distribute the hydrogen, nitrogen, oxygen, illuminating gas, water, compressed air, and other services (12 in all) to the operating machines. More than 13,400 forty-watt fluorescent tubes supply the proper illumination required for the precision manufacturing operations. An acoustical ceiling covers the entire main floor with the space above the ceiling being used as a plenum chamber for return air. The floor of the main building is of laminated construction consisting of 3 × 6-in. timbers laid on edge and covered with strip maple flooring. The building itself performs a proportionate role in keeping the indoor atmosphere under control. For example, the exterior walls consist of a layer of face brick backed by 4 in. of common brick, 1 in. of rigid inorganic insulation and vapor seal, plus an inside lining of 4-in. glazed tile. Except for doorways the interior is completely sealed off. It takes 12 hours for solar heat to penetrate the walls and four hours to penetrate the roof. A "vision strip" of Thermopane girds the entire building.

The air-conditioning system maintains any temperature between 70 and 80 F, at plus or minus two degrees and a relative humidity between 40 and 55 per cent throughout the year. The system processes some 750,000 cu ft of air per minute and maintains an indoor pressure slightly greater than the outdoor pressure or that of the office building to which it is connected.

Other buildings of the unit include a two-story office building equipped with air conditioning and acoustical ceilings, and a utilities building which houses four boilers for generating steam, the water-chilling system for air conditioning, water-softening equipment, an incinerator, fire pumps, and the watch-service headquarters. At some distance from the main units is a gas-generating plant which is a one-story steel-frame structure with explosion venting steel sash. This plant is capable of producing 1800 cu ft of hydrogen, 2400 cu ft of oxygen, and 2500 cu ft of nitrogen per hour for use in the manufacturing process.

An interesting example of the type of work being done at Western Electric's new plant is the manufacture of type 408A miniature electron tubes. Each tube weighs only 6 grams. A typical step in the manufacture of miniature tubes is the opera-

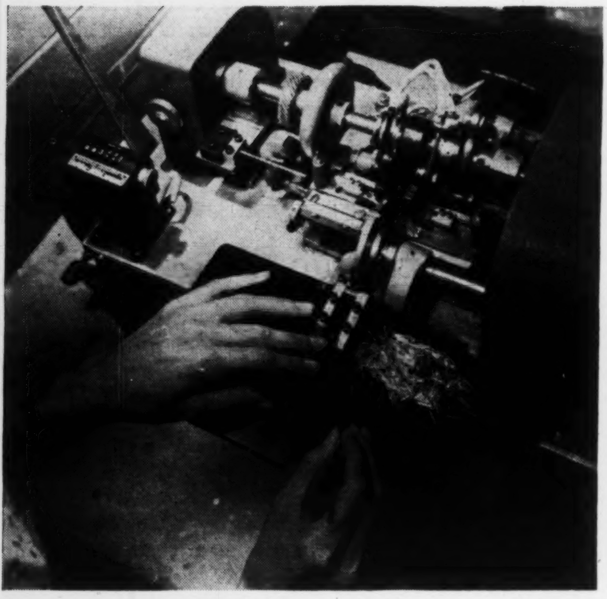

FIG. 7 WELDING NICKEL WIRE TAB TO ENDS OF CATHODE OF MINIATURE ELECTRON TUBE

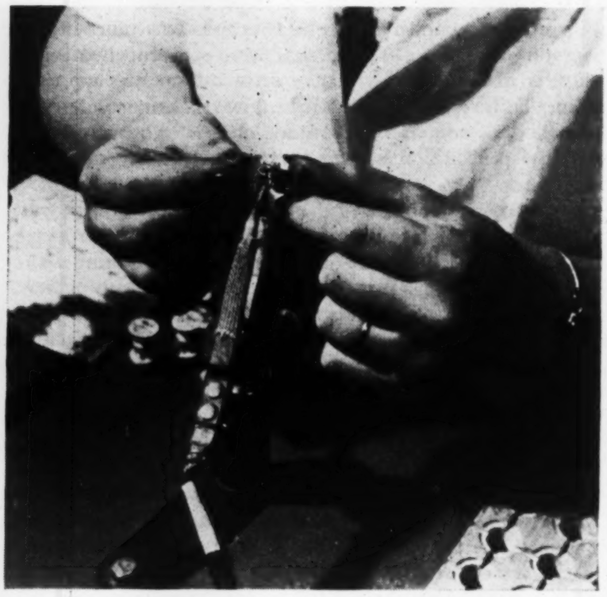

FIG. 9 WELDING HEATER CONNECTIONS IN THE MINIATURE TUBE MOUNTS WITH TWEEZER ELECTRODE

tion shown in Fig 7, where deft fingers, handling the small parts with tweezers, place cathodes, which are hollow nickel cylinders about 0.025 in. in diam, in a machine that welds tiny wire tabs, 0.006 in. thick and 0.002 in. wide, to the ends of the cathodes. A ten-minute heat-treatment at 750 C cleans and degases the cathodes, preparing them for the coating operation.

The rotary machine shown in Fig. 8 is used for the making of glass bases for the 408A miniature electron tube. After the operator places seven pins in tiny holes and places a glass cylinder in a socket surrounding the pins, the glass is carried through several successively hotter flames, melting the glass and forming it into the shape of buttons around the pins.

The delicate welding of the 408A electron tubes, Fig. 9, is performed by an operator using a specially designed electric spot welder. In the operation shown, the stem or lower half is welded to the upper section.

Maintenance of extremely close tolerances is a requisite in the manufacture of these miniature tubes. Closely knit teams of girls assemble the elements of the tubes. Working with each team is a verifier, Fig. 10, who inspects the completed assembly microscopically before it is pumped free of gases and sealed. After being sealed, the tubes are aged under carefully controlled conditions to assure stability and uniformity of performance. See frontispiece, page 956, of this issue.

Thousands of these tubes are used in the nation's telephone system.

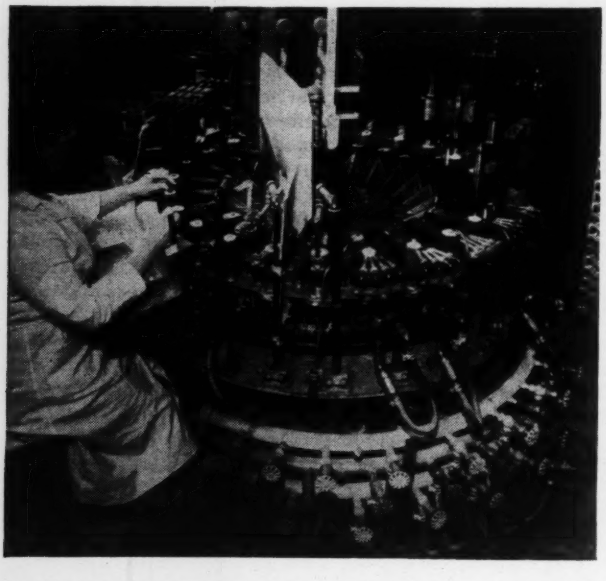

FIG. 8 ROTARY MACHINE USED FOR MAKING GLASS BASES FOR MINIATURE ELECTRON TUBES

FIG. 10 MICROSCOPIC INSPECTION OF MINIATURE-TUBE ASSEMBLIES BEFORE SEALING

Spring Transducer

A HIGHLY sensitive mechano-electrical transducer, which transforms slight displacements into large changes of resistance, current, or voltage, is being developed by W. A. Wildhack and his associates of the National Bureau of Standards. The active element of the device is a helical or conical spring wound in such a way that the initial tension varies slightly along its length. Thus when the ends of the spring are pulled apart, the turns separate one by one rather than simultaneously.

When the spring is entirely closed, it has an electrical resistance approximately that of a cylindrical tube. When it is completely open, its resistance is that of the total length of the coiled wire. Resistance can thus be varied over a wide range by stretching the spring. As the percentage change in resistance may be hundreds of times greater than the percentage change in length, displacements as small as $^1/_{100,000}$ of an inch can be measured easily without the use of electrical amplifying devices. The spring transducer thus provides a sensitive means for conversion of any mechanical displacement to a change in an electrical quantity that can be precisely determined. When connected to another transducer which gives a mechanical displacement output (a bimetallic strip responding to temperature changes, for example), the combination gives an easily measurable electrical output. This type of use suggests numerous scientific and industrial applications, including strain gages, pressure elements, accelerometers, electric weighing devices, automatic temperature controls, direct-current and alternating-current inverters, and voltage regulators.

The preferable construction for the transducer is a four-arm bridge of which each arm is a variable-resistance spring. An increase in applied tension elongates one pair of springs and shortens the other pair. The resistive unbalance of the bridge, as indicated by a galvanometer, thus gives a measure of the displacement that has occurred. With this arrangement, since the voltage can be nearly reversed through the bridge, the output voltage can be theoretically twice the input voltage.

The variation of the initial tension of the spring along its length may be accomplished in several ways; by conical winding, by varying the angle of feed of the wire on a uniform mandrel, or by varying its tension as it is wound. For greatest sensitivity the variation in initial tension is made quite small. To decrease contact resistance between successive turns of the closed spring, a high average initial tension is built into the spring, and the turns are coated with 0.0001 in. of gold. Thus far, nickel-alloy wire has been used mainly because of its high resistivity and small change of mechanical properties with temperature.

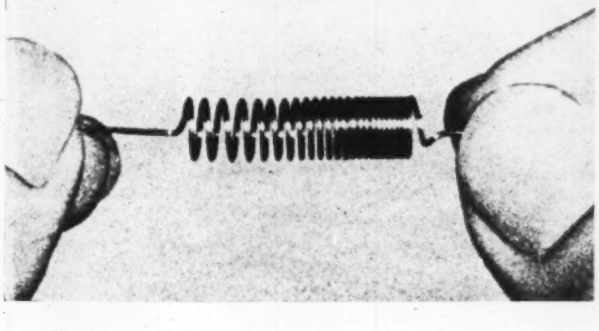

FIG. 11 THE PROGRESSIVELY GREATER SEPARATION OF THIS STRETCHED SPRING ALONG ITS LENGTH ILLUSTRATES THE BASIC PRINCIPLE OF MECHANO-ELECTRICAL TRANSDUCER

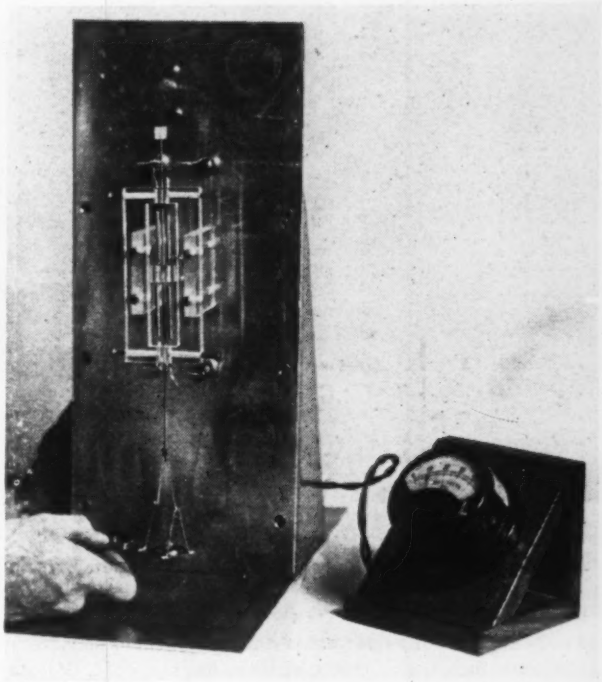

FIG. 12 EXPERIMENTAL MODEL OF NEW MECHANO-ELECTRICAL TRANSDUCER

The new transducer is undergoing further development at the National Bureau of Standards as part of a project on basic instrumentation for scientific research supported by the Office of Naval Research.

Nonflammable Hydraulic Fluid

DEVELOPMENT of a new fire-resistant hydraulic fluid for use in aviation was disclosed recently at a press conference held at the Waldorf-Astoria Hotel, New York, N. Y., in a joint announcement by the Douglas Aircraft and Monsanto Chemical Companies, who described the new fluid as a synthetic liquid combining most of the desirable characteristics of existing hydraulic fluids with fire-resistant qualities never before attained.

The new product has long been sought as a vital factor in safe operations of modern air transport and warplanes.

Under a joint agreement, Douglas will continue development work and inaugurate an operational test program, while Monsanto's manufacturing and distributing organization will have the assignment of producing and marketing the fluid, which will be known as Skydrol.

A new pressure transfer medium for aircraft hydraulic systems, Skydrol is a mobile, oily, nonflammable-type fluid. It was developed for use in cabin superchargers, expansion turbines for air-conditioning systems, and for the hydraulic system itself—in all types of aircraft.

The hydraulic system is operated by pumps, usually gear or piston type, and develops high pressures at high flow rates upward of 3000 psi. The fluid is used to activate the mechanism that controls such devices as the retractable landing gear, brakes, wing flaps, and even windshield wipers.

Because high-pressure hydraulic systems on aircraft may occasionally spring leaks, nonflammability is one of the most desirable characteristics in a hydraulic fluid. A leak causes the

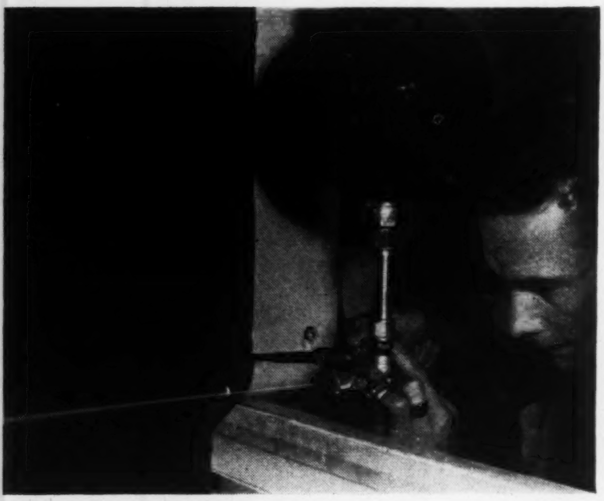

FIG. 13 HIGH-TEMPERATURE IGNITION TEST

(When sprayed from a small orifice, Skydrol fails to ignite even in contact with the blue-tipped flame of an oxyacetylene torch.)

fluid to be expelled as a fine mist. A flammable fluid may catch fire from exhausts, from contact with the hot manifold, or from sparks in the electrical system.

As a method of flammability comparison, the Aircraft Industry Association established a reference fluid, designated HS-1. This compound is a standard for nonflammability, but it is not itself hydraulic fluid. Tests for flammability were set up to compare potential hydraulic compounds with the reference fluid.

In a high-temperature ignition test, the reference fluid HS-1 ignites in bursts and carries the fire. As soon as the ignited source is removed, however, the flames go out. Under this test, Skydrol hydraulic fluid has much difficulty in flashing and is self-extinguishing. It exceeds the reference fluid requirements.

In a simulated hot manifold test, a stainless-steel pipe to which a bead has been welded, is electrically heated to a temperature of 1300 F. The test fluid is dripped on the bead of the hot manifold and is allowed to run the length of the pipe before dripping off into a catch pan. Somewhat flammable materials catch on fire the moment they strike the hot metal, burn as they run down the pipe, and then catch the drip pan on fire as they fall. Reference fluid HS-1 catches fire as it runs down the pipe, but does not carry the fire to the pan. The reference fluid extinguishes itself when it leaves the hot pipe. In the manifold test Skydrol does not burn on the pipe and far exceeds reference fluid requirements.

Another test, a low-pressure spray test, consists of igniting a standard rag saturated with 120-grade standard aircraft-engine oil and spraying the burning rag with fluid from a paint-spraying nozzle. Slightly flammable liquids cause the burning oil and rag to flare up and burn more fiercely. The reference fluid, HS-1, does not increase the intensity of the flame when sprayed into the fire although it may itself burn in the area of the existing fire. In other words, it does not feed the fire. In this test, Skydrol hydraulic fluid does not increase the intensity of the fire and thus equals the performance of the reference fluid.

The autogenous ignition point of the new fluid is 1050 F. The autogenous ignition point of the Aircraft Industrv Association reference fluid HS-1 is 750 F; petroleum hydrocarbon fluids undergo self-ignition at about 500 F.

Other characteristics of Skydrol include its high lubricating power. Its use is reported to greatly extend the service life of pumps and other working parts of the hydraulic system. The lubricity of the new hydraulic fluid is said to be at least double that of most hydraulic fluids in current use.

It has a viscosity index of 160, assuring only a small viscosity change over a wide range of temperatures. Skydrol, it is claimed, operates satisfactorily at temperatures down to —40 F.

Skydrol hydraulic fluid was operated in an aircraft hydraulic system test stand for the equivalent of more than 4000 flight-hours under maximum pressure at a temperature of 160 F. The viscosity loss due to shear breakdown was less than 18 per cent. Presently used fluids undergo 30 per cent breakdown in about 2000 flight-hours of operation.

After the equivalent of 4000 flight-hours, examination of a Vickers pump used in the test showed that it was still in serviceable condition. The longest run under the same conditions with previously acceptable fluids was equivalent to slightly more than 2000 flight-hours and resulted in complete destruction of the pump. In this performance test it was shown that Skydrol doubled the operational life of the pump used in the test run and kept all other parts of the system requiring lubrication in excellent condition. The pump, after test run, was returned to test-stand use.

According to company spokesmen, the new fluid has excellent stability under high shear stress. It operates satisfactorily with hydraulic pressure up to 5000 psi with negligible loss of film strength. It is heat-stable and oxidation-resistant. There is practically no volume loss or viscosity change due to evaporation.

It was pointed out that this new hydraulic fluid will not attack aluminum, magnesium, aircraft bearing alloys, copper, steel, or other structural metal. Chemically, it is virtually inert. The fluid is an ester base compound and does not contain halogenated hydrocarbons or salts. It does not contain water. It is a chemically stable organic compound and is extremely resistant to aeration oxidation. It does not deteriorate in service and hence does not result in corrosive breakdown products.

Since it is an altogether new type of hydraulic fluid, gaskets and packing material suitable for earlier fluids are not suitable for this new hydraulic fluid. Packing or gaskets of natural rubber, synthetic rubber, or Neoprene will require replacement in installations where volume changes are objectionable. In using the new fluid, consideration should also be given to

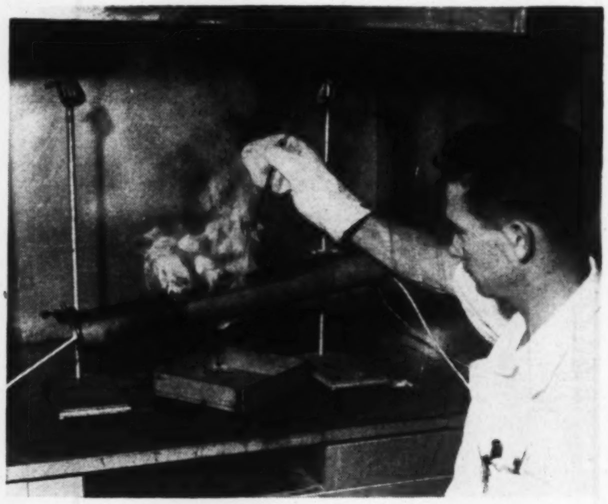

FIG. 14 SIMULATED HOT MANIFOLD TEST

(When Skydrol is dripped onto a stainless tube heated internally to 1300 F, it vaporizes instead of igniting.)

adjacent electric wiring, as this fluid has a tendency to soften most insulation if plumbing leaks cause immersion of the wire in the fluid. Nylon-type insulation will prevent such softening.

The chemical and physical properties of Skydrol hydraulic fluid are as follows: odor, pleasant and mild; color, clear and light green; specific gravity at 60/60 F, 1.079; neutralization No. (mg KOH/gm), 0.18; viscosity in centistokes, at −30 F, 2256, at 100 F, 15.0, at 210 F, 3.85; ASTM pour point, below −60 F; autogenous ignition temperature (ASTM), 1050 F; viscosity index, 160.

In addition, this hydraulic fluid is not a toxic compound. It gives off no dangerous fumes nor does it attack the skin. No special precautions are required for handling or storing.

Continuous Fuel Injection

A CONTINUOUS fuel-injection system with rotating fuel chamber is discussed in an article in *Engineering*, Oct. 1, 1948, by A. Muraszew.

He states that one of the important requirements in turbine engines for aircraft is the burning of large quantities of fuel in a relatively small combustion chamber. Among other factors, the efficiency and intensity of the combustion process depend greatly on the degree of fuel atomization achieved and on the arrangements for bringing the combustion air into intimate contact with the fuel particles in the shortest possible time. The time for complete combustion of the fuel particles will determine the minimum length of the combustion chamber; thus an improvement in fuel atomization will have a beneficial effect on combustion-chamber size.

In existing fuel systems for gas turbines an improvement in atomization will require an increase in injection pressure, which would impose new requirements on fuel pumps, already working under severe conditions of high pressure (up to 1000 psi), and high output (up to 1000 gph). With a fuel-injection system relying on centrifugal force to give the required injection pressure, Mr. Muraszew points out the following advantages: Good atomization of the fuel over a wide range of load and speed, this atomization improving with increasing speed; the fuel pump is subjected only to low pressure and high-pressure fuel pipes are eliminated; improved air-fuel mixing conditions, giving the possibility of increased combustion intensity.

In this fuel system the atomization of the fuel is achieved by the centrifugal force of the fuel rotating with the fuel chamber, which can conveniently be fitted on the existing compression turbine shaft, as shown in Fig. 15. Experiments at Porton Laboratory on the atomization of liquids by a rotating disk have shown the spray to be remarkably homogeneous and composed mainly of fuel droplets of the same size surrounded by very small "secondary" droplets. The very small droplets, although only a trifling proportion of the total volume of fuel, may, however, be very useful in the initiation of combustion.

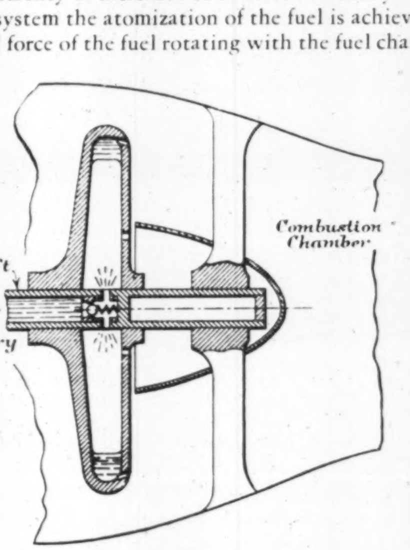

FIG. 15 CONTINUOUS FUEL-INJECTION SYSTEM WITH ROTATING FUEL CHAMBER

The rotating fuel chamber may also form one end of an annular combustion chamber and atomized fuel is discharged from the fuel chamber through a series of plain-orifices placed conveniently around the outer part of the fuel chamber, or from a circumferential slot, as shown in Fig. 16. Fuel is delivered into the fuel chamber through a nonreturn valve from a fuel pump which delivers against the relatively low pressure at the center of the chamber. The fuel supply from the pump can be delivered to the fuel chamber through the compressor-turbine shaft. The fuel sprays discharged from the orifices can be directed in relation to the air flow so that the relative velocity is increased; this would improve both the atomization and the mixing process. The high tangential velocity of the fuel droplets issuing from the discharge orifices is also an important factor in improving the atomization.

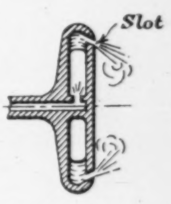

FIG. 16 ROTATING FUEL CHAMBER

The conditions of fuel discharge and spray atomization existing in such a fuel-supply system are illustrated by Mr. Maraszew with a theoretical analysis. A practical example is worked out as an illustration.

Automatic Rocket Launcher

AN automatic rocket launcher, mounted in the nose section of a Lockheed P-80A jet airplane is being developed to provide the U. S. Air Force with an automatic rocket-firing installation to be used in a high-speed airplane. This experimental item is a six-round, automatic rocket launcher, electrically powered, and designed to launch the 38-lb, 4.5-in-diam folding-fin M9A3 or T-46 rocket.

This automatic rocket launcher, developed by the United Shoe Machinery Corporation, in co-operation with the Armament Laboratory, Air Materiél Command, Wright Field, Dayton, Ohio, underwent preliminary ground and flight tests at the Air Materiél Proving Ground, Eglin Field, Fla., during March and April, 1947.

The preliminary ground and flight tests have indicated functional and structural suitability with no noticeable effect on the operation of the jet engine during the air-firing of the rockets. However, it was found necessary to cut louvers in the gun access doors of the P-80A test airplane to equalize the pressure differential resulting from rocket blast.

Access to the mechanisms of the launcher for maintenance and loading is made through the doors located on both sides of the nose section of the fuselage. The gun access doors are located in the area where louvers have been cut to equalize the pressure differential resulting from rocket blast.

This launcher is installed as a fixed gun within the contour of the aircraft in contrast to those used in World War II which were installed on the wings. It is the first automatic rocket installation on a jet aircraft or a fighter of any type. Some of the main objectives for this experimental launcher are to reduce drag and increase accuracy and rate of fire power. In the case

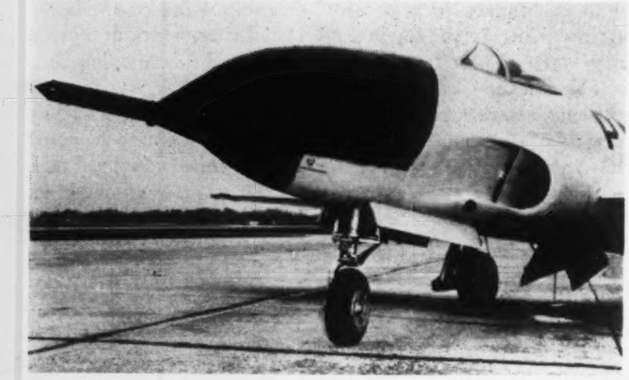

FIG. 17 ROCKET BARREL OF NEW AUTOMATIC ROCKET-LAUNCHING INSTALLATION ON P-80A JET AIRPLANE

of wing installations, drag is prohibitive since it costs 60 to 70 mph to carry six rounds.

This project was activated to obtain engineering data and operating characteristics of an automatic rocket launcher in a high-speed airplane. Standardization of this launcher is not anticipated. The type of rocket used is somewhat obsolescent and its rate of fire is not entirely satisfactory. It is highly probable that when standardization is considered, it will be redesigned around a more up-to-date rocket.

It is the third experimental automatic rocket launcher developed and air-fired by the Air Force. A previous development was installed on a B-25 and used in combat in India during March, 1944. The recent successful preliminary ground and flight tests of the present launcher give indications of the availability of such an item should the need arise. However, it is not wise to terminate developments and tests in the preliminary stage. Consequently, thorough testing and the development of additional characteristics are in progress.

Productivity

MORE effective use of knowledge already known is the key to increased productivity in the United Kingdom rather than the development of new natural resources or an increase in industrial research, according to Sir Henry Tizard, chief scientific adviser to the British Government.

In his presidential address before the British Association for the Advancement of Science, Sir Henry said the following:

"Taking British industry as a whole, productivity is far lower than in the United States. In both countries about 40 per cent of the population is gainfully employed. In the United Kingdom the proportion engaged in manufacturing, building, and civil engineering, which covers the production of all capital and consumer goods (other than minerals or food) is now a little under 18 per cent of the population. In the United States the corresponding figure is 12 per cent; and yet in proportion to the population, the volume of production is far higher than in the United Kingdom."

In discussing the causes of relative productivity of nations, Sir Henry mentioned Switzerland and Sweden with relatively high productivity, and continued:

"These two countries cannot be said to possess natural resources superior to ours; nor can it be argued that in the quality or quantity of scientific and industrial research they excel us but I suggest that they, in common with the United States, possess a higher average standard of technology than we do and have a much greater proportion of men of high scientific education in executive control of industry.

"It is not the general expansion of research in this country," he said, "that is of first importance for the restoration of its industrial health and certainly not the expansion of Government research remote from the everyday problems of industry. What is of first importance is application of what is already known."

Nuclear Physics Charts

SIX lithographed wall charts in two colors illustrating the important areas of nuclear physics have been prepared by the Westinghouse Electric Corporation's School Service for use in classes in schools and colleges.

Measuring 25 × 36 in. and made of heavy stock, the charts are accompanied by a 32-page book of valuable supplementary information. The price for the complete set is $1.

The first chart illustrates and describes the basic particles important in nuclear physics; the proton, neutron, alpha particle, beta particle, gamma ray, deuteron, positron, meson, and the neutrinos. The second chart explains how nuclei are put together, depicting some 635 isotopes and 75 isomers It also illustrates and explains mass defect, binding energy, and Einstein's mass-energy formula.

Natural and man-made nuclear reactions are depicted in the third chart which includes solar reactions, natural radioactivity, nuclear fission, as well as typical reactions induced by various kinds of atomic bullets. The fourth chart portrays eleven types of apparatus for detecting and inducing nuclear reactions including the ionization chamber, Geiger counter, Wilson cloud chamber, and modern atom smashers.

The fifth chart shows five areas for the useful application of atomic energy. The construction and operation of the atomic pile are described. Illustrations of tracers, research, medical therapy, and the atomic bomb are included.

The last chart covers the major theoretical, experimental, and engineering achievements in nuclear physics, pointing out 38 contributions, from the discovery of natural radioactivity and x rays to the current developments.

Uranium Production

THE United States Atomic Energy Commission announced that negotiations are being conducted with the Vanadium Corporation of America for the purchase of uranium from two treatment plants to be brought into operation by VCA in 1949.

One of these plants is the Commission-owned vanadium-uranium mill at Durango, Colo., for which a lease is being arranged. The other is a new plant to be erected by the company in the White Canyon district of southeast Utah.

Under terms of the tentative agreement the government-owned processing plant at Durango will be rehabilitated by the Vanadium Corporation of America at a cost to the company estimated to be more than $200,000. The plant, a vanadium mill formerly owned by the U. S. Vanadium Corporation, will be leased to the Vanadium Corporation of America. Operations probably will start in late 1949.

It is anticipated that ore will be supplied principally by VCA mines and independent operators will be able to deliver ore under the terms of the Commission's ore-purchasing program.

Part of the ore to supply the plant may come from properties now held by the AEC on the Navajo Indian Reservation. Negotitations are in progress between the Commission and

VCA for the subleasing of these properties to the company on a royalty or similar basis. If this plan is approved, royalties on all minerals extracted will be paid to the Bureau of Indian Affairs for the Navajos. A relatively small amount of ore was mined on the reservation during the war.

In the White Canyon district in San Juan County, Utah, VCA will set up a pilot treatment plant which will be in operation by next summer.

In this area, which has not previously been mined, the copper-uranium-ore bodies are described as small, flat, and lenticular.

The AEC and VCA are negotiating an agreement for the purchase by AEC of a high-grade uranium product from the new mill. Ultimately VCA may build a larger treatment plant in the White Canyon district. It is expected that the opening of this plant, capable of treating custom ores, will stimulate prospecting and mining in this new district.

Length Standardization

THE photograph, Fig. 18, was awarded first prize in the Second Photograph-In-Science Salon of the American Association for the Advancement of Science, September, 1948. Interference fringes formed by the green radiation of natural mercury (*left*) and of mercury 198 (*right*) are shown. Mercury 198 is a stable isotope made by bombarding gold with neutrons in an atomic pile.

The wave length of the green radiation of mercury isotope 198 is said to provide a new and better standard of length. Its spectral line represents the ultimate in sharpness and intensity that can ever be obtained from any atom, either natural or artificial. From these fringes, contrasted here with the broader fringes of seven-isotope natural mercury, Dr. William F. Meggers of the National Bureau of Standards has measured the wave length of Hg^{198} radiation with an accuracy of one part in a hundred million. One part in a billion is theoretically possible. Radiation is obtained by exciting a few milligrams of Hg^{198} in a simple glass tube using high-frequency radio waves. Because Hg^{198} provides greater precision, reproducibility, and convenience than either the standard meter or the red line of cadmium, the National Bureau of Standards presented it for consideration as the world's primary standard of length at the International Conference of Weights and Measures which met in Paris, France, Oct. 12–21, 1948.

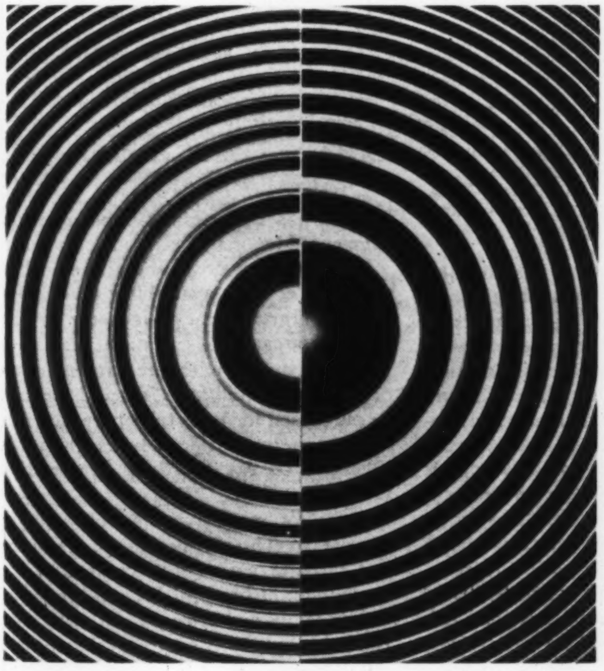

FIG. 18 PRIZE PHOTOGRAPH

The development of such a standard source of wave length will be of inestimable value in the future refinement of physical optics. For example, two obvious applications are a more accurate determination of the velocity of light, and the measurement of dimensions, planeness, and expansion of mechanical and optical parts by interferometric methods.

Electronic Calorimeter

AN electronically controlled heat-measuring machine, developed as a result of wartime research, has been designed by Associate Professor J. M. Sturtevant at Yale University, New Haven, Conn. The machine is a twin calorimeter, so sensitive that it can record a temperature change of only a few thousandths of a degree in an hour. The instrument, which took two years to perfect, costs more than $4000, and was constructed under a grant from the American Cancer Society.

It consists, basically, of two calorimeters made of tantalum which is very resistant to chemicals. A jacket of aluminum surrounds the calorimeters, and is in turn inside a watertight chamber in a bath of temperature-controlled water. The calorimeters themselves are small as compared with most similar devices and hold only 25 cc. Each chamber is divided in the center by a valve. In one, the chemical reaction is started and in the second, the temperature is kept identical by means of electricity. Each calorimeter of the heat-measuring machine is used to measure what takes place simultaneously in the other.

The electrical energy is supplied by passing a current through a wire winding which acts much like the heating unit of an electric toaster but on a much smaller scale. A computer similar to those used in wartime gunfire controllers computes the electrical energy by multiplying the square of the voltage times the elapsed time. This process is done by electromechanical computers and is carried on automatically and continuously during an experiment. Indication of any change in temperature of the chemicals being studied is obtained by electrical thermometers. Normally the temperature change is so small that the output of the electrical thermometer must be amplified 10 million times. Then a proportionate voltage is fed back to the cooler calorimeter so that the temperature of the two calorimeters can be equalized. Thus the heat change is automatically determined by the electronic apparatus.

Investigations are planned to study the heat changes which occur when antibodies react with the serums or antitoxins which cause them to be produced. The heat of this type of reaction has never been measured with accuracy by scientists. Knowledge of the heat loss or gain is expected to throw new light on the forces which exist between antibodies and antigens.

Measuring the electrical energy produced provides a much more precise method of determining heat loss or gain than was previously possible for slow reactions. The machine will be used to measure heat quantities resulting from protein reactions which include, among other things, processes of cell growth and division, so important in the cancer problem.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Process Industries

Sink-Float Processes, by John T. Sherman, American Cyanamid Company, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-40** (mimeographed).

The utilization of the force of gravity to separate valuable minerals from worthless minerals is one of the oldest and cheapest methods of concentration.

In order to be amenable to sink-float treatment, an ore must, on crushing, break into fragments that have sufficient differences in mineral content to cause a difference in specific gravity between the valuable pieces and those too low in valuable mineral content to justify further treatment. Those that require crushing finer than $^1/_4$ in. in order to obtain this difference in specific gravity, are generally not suited, as the lowest size of ore treated is 14 mesh and as this size is approached by the crusher the percentage of the ore that can be treated becomes too small to make the use of these methods attractive. The extremely accurate gravity separation that can be made by these methods does, however, make a wide range of ores amenable.

These may be treated to produce directly salable products and discardable waste or they may be separated into discardable waste products and enriched products that are to be treated by other methods after reduction in size. Because of low capital cost and cost of operation, sink-float plants can be used to grade up submarginal ores to the point where they can be treated profitably. Waste dumps and coarse tailings from less efficient concentration methods can be treated. Cheaper less selective mining methods can be used and the waste discarded prior to concentration by older conventional methods. Thus large new reserves of mineral resources are, in effect, created by new methods of concentration.

Although many ores cannot be treated by sink-float methods, practically every coal can be cleaned by one or more of these processes. This fact becomes increasingly important as the better seams of coal are exhausted and it becomes necessary to use lower-grade coals more difficult to clean. The increasing use of mechanized mining and full-seam mining throws a greater burden on the cleaning plant because of the larger and more variable quantity of refuse in the coal. Heavy-media separation is ideally suited to this service because of the ease with which a constant medium gravity can be maintained under adverse conditions and the ability of the equipment to remove the sink product continuously. Eight plants employing heavy-media separation processes are now built or under construction for cleaning anthracite and bituminous coals. This field offers great scope to sink-float methods.

Although commercial sink-float installations have been restricted to the treatment of material coarser than 10 to 14 mesh, pilot-plant studies, made at the Mineral Dressing Laboratory of American Cyanamid Company, indicate the possibility of making good gravity separations on particles as fine as 48 mesh in the case of ores and as fine as 100 mesh in the case of coal. This development will help to close the gap between gravity methods of concentration and froth flotation, the most efficient method of concentrating fine ores and coal.

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Effect of the Introduction of Natural Gas on a Highly Industrialized Territory Previously Supplied With Manufactured Gas, by Paul R. Taylor, Stone & Webster Service Corporation, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-41** (mimeographed).

The delivery of natural gas through large-diameter pipe-line systems to areas heretofore unconnected with sources of natural gas always gives rise to much speculation concerning the use of that product. Communities never before served by natural gas are inquisitive concerning the characteristics, the cost, the reliability, the safety, and the economic utilization of this fuel. Every area approached by natural-gas pipe lines shows keen interest in what the effect will be on local industry in so far as its improvement and growth are concerned. Based upon experience and observation, this paper has been prepared for the purpose of delineating the resultant effects upon industry in communities whose manufactured-gas facilities have been either augmented by or adapted to natural gas.

Natural gas is now, or will be within two or three years, available in practically all the large centers of industry in the United States.

In comparison with present-day costs of solid and liquid fuels, natural gas can be purchased for industrial purposes at a cost per therm considerably less than it is necessary to pay for these competitive fuels.

Costs for natural gas should remain comparatively stable because the earnings and rates of natural-gas companies are controlled either by Federal or State Commissions and prices of natural gas in the field are usually set for a considerable number of future years.

Industrial load of a type that can be

served with straight natural gas on an interruptible basis is desirable to the extent that it will offset seasonal loads. The consequent improvement in system load factor results in lower costs per Mcf.

Natural-gas service to an all-year industrial customer makes it unnecessary for the customer to carry large inventories of solid and liquid fuel that would otherwise be required to guard against interruptions resulting from labor disorders, transportation delay, or changing prices. These same advantages are realized to a certain extent by the industrial customer whose service is interruptible. Some stand-by fuel stocks must be maintained for use at times of interruption. Usually the cost of gas to this type of customer is less than to the all-year user.

In addition to the savings in actual cost of natural gas, further savings are achieved by both the distributor and the ultimate industrial consumer because of less labor required for the unloading and storage of solid and liquid fuel and for the disposal of ashes resulting from the use of solid fuel.

Natural gas, being of constant heating value, specific gravity, and burning characteristics, is ideal for use in any type of industry where heat is required and especially desirable for industrial uses where close temperature control, cleanliness, and freedom from injurious ingredients are required.

Considerations Affecting Sound Utilization of Gas, by Carl Wierum, The Brooklyn Union Gas Company, Brooklyn, N. Y. 1948 ASME Annual Meeting paper No. **48—A-42** (mimeographed).

The effective utilization of gas fuel is practically unlimited in scope. There is hardly any type of industrial heat application to which gas fuel cannot be adapted, assuming that its availability and the economies of the given situation favor its use. Gas fuel is in use today in large quantities for such operations as heating open-hearth furnaces, lime and cement kilns, glass and ceramic furnaces, and oil-refinery stills. Due to an expanded synthetic-rubber program, great quantities of natural gas are also used in the manufacture of carbon black. Other nonfuel uses include process-atmosphere generation, and conversion of natural gas to gasoline. Some basic factors which must be taken into account in any attempt to apply gas to an unusual or nonstandard problem are as follows: (*a*) Btu of gas, (*b*) specific gravity, (*c*) pressure at which gas is available, (*d*) air required for combustion and its source, (*e*) rate of flame propagation. Only when these fundamentals have been obtained can we go ahead to consideration of the amount of actual heat needed and the method with which we are going to apply this heat.

The industrial engineer confronted with a heating problem can go to three sources for specialized advice: (1) The local gas company, if your plant is served by a utility, may have a group of industrial utilization engineers; (2) The Gas Appliance Manufacturers Association, with offices in New York and Washington, D. C.; (3) The American Gas Association headquarters at 420 Lexington Ave., New York, N. Y., has utilization engineers well versed in every sort of heating problem.

In addition to the foregoing there are many excellent consulting engineers who have had great experience in connection with different phases of industrial gas utilization.

Heat Transfer

Cooling-Tower Analysis, by Joseph Lichtenstein, The Tower Company, New York, N. Y., 1948 ASME Annual Meeting paper No. **48—A-32** (mimeographed).

There is need for a design equation for cooling towers which would permit determination of the performance from essential design features. Various designs could thus be compared to arrive at best solutions, or competitive designs could be evaluated for selection.

To arrive at such a design equation requires a method of analysis of existing over-all test data. This is attempted by substituting for the real tower a combination of prototype film and drop towers assumed to have the same performance as the real tower. A sample analysis of a typical tower is made in which the functions of each component part of the tower and its contribution to the total performance is evaluated.

Cooling towers are towers in which a liquid is in direct contact with a gas. The surface required for performance is produced by drops of the liquid in combination with geometrical film surfaces over which the liquid flows. In this study particular consideration is given to towers for the system air and water.

The real tower, which is a combination of film and drop parts, does not lend itself to simple analysis. In the real tower there is at any time a variety of drops of different shapes and dimensions. Their formation is influenced by the existing film surface, its shape, and arrangement, and also by the magnitude of the air velocity. It is useful in such cases to replace the complicated real parts by idealized prototypes which are well-defined. Although the behavior of these prototypes may not correspond quantitatively with reality, it will essentially describe the real tower. Quantitative agreement could be reached by the introduction of correction factors. In following this procedure, the pure drop tower and the pure film tower are introduced. The behavior of each alone, or in combination with each other, is studied. In the paper it is assumed that the real tower can be represented by a combination of a pure drop tower working in series with a pure film tower and this in turn in parallel with another pure film tower.

Equations are developed that permit the calculation of the characteristics of a specific design essentially from the design variables, providing the drop-diameter function for the film has been determined from tests. The designer could use them for comparative design studies, and the purchasing engineer for studies of competitive designs in the selection of cooling towers.

A typical curve indicates the respective roles played by the film and drop surfaces within the tower and leads to the conclusion that each has its useful functions. The usefulness of the drop part predominates at small and moderate characteristics, whereas for large requirements the film part is decisive.

Flow of Heated Gases, by A. Stanley Thompson, North America Aviation, Inc., Downey, Calif., 1948 ASME Annual Meeting paper No. **48—A-45** (mimeographed).

The purpose of the present investigation was to find a convenient method for correlating the variables involved in the transfer of heat from the wall of a passage to a gas moving at high velocity in the passage. A graphical design method has been developed, using the Reynolds analogy between heat transfer and friction, for one-dimensional flow in a passage of variable area, and with variable wall temperature. For a given problem a plot is rapidly obtained relating area, pressure, Mach number, and temperature. A separate plot relates these variables to length along the passage.

It has been assumed that the laws for a perfect gas can be used for small steps throughout the range of application and that the Reynolds analogy between heat transfer and friction is applicable. No discontinuities such as shock waves have been considered.

The use of the chart involves a stepwise approximation to the actual flow composed of processes at constant Mach number occurring in a finite length of passage, and of processes at constant total temperature (isentropic), assumed to occur in a zero length of passage.

The equations for compressible fluid flow in the steady state (conservation of momentum, continuity of flow, and conservation of energy) are combined, by means of the Reynolds analogy between heat transfer and friction, with the equation for heat transfer across a fluid boundary. The differential equation thus obtained is integrated for two special cases, an isentropic process, and a process at constant Mach number with constant wall temperature, giving expressions for pressure and area ratios in terms of Mach number and total temperature of the fluid. Next, the heat-transfer equation is integrated, for the special case of constant heat-transfer coefficient, to give an expression for total temperature in terms of distance along the fluid passage.

It is assumed, wherever this is necessary to expedite an integration, that all integrations are performed over ranges small enough so that the terms for the ratio of specific heats, hydraulic radius, friction factor, heat-transfer coefficient, and wall temperature can be considered constant for the integration interval.

An investigation is made of the limitations imposed by requirements of the second law of thermodynamics to the variables of fluid flow in heating with boundary friction.

The flow is considered to be one-dimensional, that is, the cross section of the passage changes slowly with distance and the passage is essentially straight.

Oil and Gas Power

Energy in the Engine Exhaust, by P. H. Schweitzer, Mem. ASME, and T. C. Tsu, Pennsylvania State College, State College, Pa. 1948 ASME Annual Meeting paper No. **48—A-56** (mimeographed).

In view of the fact that 30 to 50 per cent of the energy of the fuel released during combustion in an engine escapes through the exhaust, it is not surprising that engineers pay more and more attention to the recovery of the exhaust energy. That generally takes one of two forms. The energy of the exhaust is either used for heating or it is used for producing mechanical work.

Recently the exhaust energy is being utilized more and more for the production of power. Compound engines, exhaust turbines, and inertia charging of cylinders belong to this category. Exhaust turbines are now widely used both for aircraft and Diesel engines for power boost. Ordinarily the power gain is only indirect. The exhaust turbine drives a blower which supercharges or helps to supercharge the engine. In some applications, however, the turbine has been geared to the main shaft to augment the engine power.

While the turbine is the most popular means to utilize the exhaust energy, it is helpful to know that the maximum amount of work that an ideal turbine is capable of producing is exactly equal to the work an ideal engine would deliver if the same exhaust gas were allowed to expand in both cases to the same ambient pressure.

Applied Mechanics

Bending of Rectangular Plates Subjected to a Uniformly Distributed Lateral Load and to Tensile or Compressive Forces in the Plane of the Plate, by H. D. Conway, Mem. ASME, Cornell University, Ithaca, N. Y. 1948 ASME Annual Meeting paper No. **48—A-12** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents a method of determining the distribution of deflection and stress in simply supported rectangular plates subjected simultaneously to a uniform lateral load and to uniform tensile or compressive forces in the plane of the plate. The problems are of particular importance in the design of a ship's bottom plating and, for this reason, graphs are given whereby the maximum stress and deflection may easily be calculated. Illustrative examples are included to demonstrate the use of these graphs. An example is also given to illustrate how the method may be extended to include the case of hydrostatic pressure.

Supersonic Diffusers for Wind Tunnels, by E. P. Neumann, Mem. ASME, and F. Lustwerk, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Annual Meeting paper No. **48—A-14** (in type; to be published in the *Journal of Applied Mechanics*).

An investigation of supersonic diffusers was conducted for conditions wherein a boundary layer was present at the diffuser entrance. The pressure rise obtained from a shock in a constant-area tube was measured, and the measurements compared with values computed from a simple one-dimensional analysis. For the range of Mach numbers covered (1.8 to 4.2), separation of the stream from the tube wall was always induced by the shock. The length of the separated region was from 8 to 12 tube diameters. The results of the tests on shocks in a constant-area tube were utilized in the design of several types of diffusers for which test data are reported at Mach numbers ranging from 2 to 3. The most efficient diffuser tested consisted of a contraction to a minimum starting area followed by a constant-area tube approximately 10 diam long. The tube was in turn followed by a subsonic diffuser. Only diffusers of constant geometry were considered.

The Dynamic Response of a Simple Elastic System to Antisymmetric Forcing Functions Characteristic of Airplanes in Unsymmetric Landing Impact, by Joseph B. Woodson, National Bureau of Standards, Washington, D. C. 1948 ASME Annual Meeting paper No. **48—A-16** (in type; to be published in the *Journal of Applied Mechanics*).

This paper presents an analysis of the dynamic response of an undamped mechanical system with one degree of freedom subjected to disturbances which are described by antisymmetric forcing functions. The analysis was undertaken to throw light on the effect on the vibration of the wings caused by unsymmetric landing impact of an airplane. Two types of disturbances are considered; a full sine-wave pulse, and a pulse which is the difference between two overlapping half-sine waves. The results are presented in the form of dynamic-response curves and dynamic-response-factor curves. The numerically greatest dynamic-response factors, approximately 3.24 and −3.26, resulted for a full sine-wave pulse disturbance with a ratio of duration of impact to natural period, $T_i/T \cong 1.11$. When T_i/T is in the neighborhood of 1, the first positive peak of dynamic response is numerically less than the negative and positive peaks which follow it. For much of the range, the positive and negative dynamic-response factors are numerically approximately equal. The analysis was confined to values of T_i/T between 0.33 and 12. As T_i/T increases without limit, the positive and negative dynamic-response factors tend to 1 and —1, respectively.

Vibration of Slender Bars With Discontinuities in Stiffness, by W. T. Thomson, University of Wisconsin, Madison, Wis. 1948 ASME Annual Meeting paper No. **48—A-17** (in type; to be published in the *Journal of Applied Mechanics*).

Vibrational characteristics of elastic bodies are altered by discontinuities in stiffness resulting from narrow grooves or cracks. This paper presents a theoretical method for determining the effect of such discontinuities on the flexural, longitudinal, and torsional vibration of slender bars.

Dynamic Capacity of Rolling Bearings, by Gustaf Lundberg, Chalmers University of Technology, and Arvid Palmgren, SKF, Gothenburg, Sweden. 1948 ASME Annual Meeting paper No. **48—A-19** (in type; to be published in the *Journal of Applied Mechanics*).

This paper is a condensation of a comprehensive theory for fatigue failure in rolling bearings. The character of bearing fatigue failures is analyzed, and the effect of the volume of stressed material is assessed by means of modification of Weibull's statistical theory of failure. The variables affecting bearing capacity are examined, and general formulas are set up relating the variables to the bearing capacity. Unknown exponents in the formulas are evaluated by means of extensive tests, and the final formulas are compared to experimental results.

Numerical Solution of Elastoplastic Torsion of a Shaft of Rotational Symmetry, by R. P. Eddy, Office of Naval Research and Bureau of Ships, Washington, D. C., and F. S. Shaw, Council for Scientific and Industrial Research, Melbourne, Australia. 1948 ASME Annual Meeting paper No. **48—A-20** (in type; to be published in the *Journal of Applied Mechanics*).

Using relaxation methods, an approximate numerical solution is found of the stress distribution in a shaft of rotational symmetry, which is subjected to a torque of sufficient magnitude to cause portions of the material to yield. It is assumed that the material of which the shaft is composed is isotropic and yields according to the condition of von Mises. The particular problem investigated is a shaft with a collar; results are presented showing the elastoplastic boundary, and the stress distribution, for two different amounts of plastic deformation.

The Shape of a Piston Ring in Its Unrestrained State, by Che-Tyan Chang, Wilkening Manufacturing Company, Philadelphia, Pa. 1948 ASME Annual Meeting paper No. **48—A-21** (in type; to be published in the *Journal of Applied Mechanics*).

It is the purpose of this paper to develop, with mathematical means, a general equation between the free shape of a piston ring in its unrestrained state and the consequent radial-pressure pattern against the cylinder wall after its installation. It is up to the designer, first to decide upon the proper pressure distribution for his particular need, and then to use such an equation as a first guide to evaluate the proper free shape of the ring so that it will give him the required radial-pressure pattern after its installation in the cylinder.

Stability of Linear Oscillating Systems With Constant Time Lag, by H. I. Ansoff, Mem. ASME, Brown University, Providence, R. I. 1948 ASME Annual Meeting paper No. **48—A-22** (in type; to be published in the *Journal of Applied Mechanics*).

This paper discusses the influence of constant time delay in transmission of the control signal upon the output system of a closed-cycle control device. The use of Nyquist's stability criterion permits investigation of the control signal proportional to any derivative of the displacement. The stability criteria are given in closed form.

Slow-Motion Pictures of Impact Tests by Means of Photoelasticity, by Ludwig Föppl, Munich Institute of Technology, Munich, Germany. 1948 ASME Annual Meeting paper No. **48—A-24** (in type; to be published in the *Journal of Applied Mechanics*).

The experiments described in this paper were carried out in investigating the distribution of stresses and their variation with time in a test bar subject to bending stresses resulting from an impact. While a series of tests have been made, only two of them will be dealt with in detail. In the first test the impact is of moderate intensity, so that the response is entirely elastic. The test results will be compared with a theoretical treatise by Saint Venant and Flamant published in 1889. In the second test the impact is strong enough to break the test bar.

The Use of the Centrifugal Pendulum Absorber for the Reduction of Linear Vibration, by F. E. Reed, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Annual Meeting paper No. **48—A-25** (in type; to be published in the *Journal of Applied Mechanics*).

A machine, consisting of rotating tuned pendulums free to oscillate in planes containing the axis of rotation, is proposed as a dynamic absorber for linear vibrations. The influences of size, exactness of tuning, and damping are investigated, and curves for evaluating the effectiveness of the machine are shown.

The use of centrifugal pendulum vibration absorbers for the elimination of torsional vibrations in internal-combustion engines has been very successful. Not only have they been useful in the reduction of torsional vibration stresses in engines of the conventional type but their use has permitted the design of gear systems which could not be expected to be reliable were the torsional vibrations not reduced. These benefits have been obtained with a relatively simple attachment which does not add appreciably to the cost and weight of the power plant.

Since the torsional pendulum absorbers have proved so successful, the question naturally arises as to whether the same principle could not be applied to the reduction of linear vibrations. Since most objectionable linear vibrations are set up by some machine, it might be possible to drive some type of pendulum absorber by the machine which would by the action neutralize the forces which the machine generates.

Stresses and Displacements in a Semi-Infinite Elastic Body With Parabolic Cross Section Acted on by Its Own Weight Only, by R. J. Hank and F. H. Scrivner, Texas Highway Department, Austin, Texas. 1948 ASME Annual Meeting paper No. **48—A-27** (in type; to be published in the *Journal of Applied Mechanics*).

The earlier solution for the stress distribution in a semi-infinite elastic wedge is compared with the solution for a cross section of parabolic shape. Displacement diagrams for two extreme values of Poisson's ratio are given for the parabolic section.

Fuels

Combustion Ash Collection for the Small Power Plant, by Philip F. Best, The Thermix Corporation, Greenwich, Conn. 1948 ASME Annual Meeting paper No. **48—A-55** (mimeographed).

There has been a tendency in the past for the small power plant owner and operator to give scant, if any, consideration to the separation of ash from the combustion gases. Very often this has been due to the fact that there has not been proper consideration given to the advantages of a good dust-collection system. An effort is made herein to point out and evaluate some of these advantages.

It is very difficult to convince the owner of a small power plant that there is any necessity for him to install an efficient ash-collection system. There are certain preconceived arguments against an efficient dust-collecting system which generally influence this owner to install a cinder trap or some system with relatively low cost and low efficiency.

According to the paper, careful consideration of all the facts will, in most cases, justify the installation of an efficient dust-collecting system regardless of the type of firing and the size of the installation.. While the primary and operating cost of the most efficient system is certainly higher, the advantages to be gained are of such consequence and so numerous as to outweigh this additional cost. In so far as efficiency is concerned, if stoker ash, as anlayzed in the paper, is collected by a centrifugal collector, the efficiency of collection will be better than 98 per cent. None of the dust emitted will be larger than 30 microns and 50 per cent will be less than 7.5 microns. There will be no dust falling within one mile of the stack in as little as a five-mile per hour wind. With this efficiency the plant owner can operate with the assurance that he is not contributing to a dust nuisance, and that his equipment will not become obsolete in the near future. Furthermore, he stands to profit greatly from the good will of the community.

Studies in Fly-Ash Erosion, by M. A. Fisher, Armour Research Foundation, Chicago, Ill., and E. F. Davis, Institute of Gas Technology, Chicago, Ill. 1948 ASME Annual Meeting paper No. **48—A-53** (mimeographed).

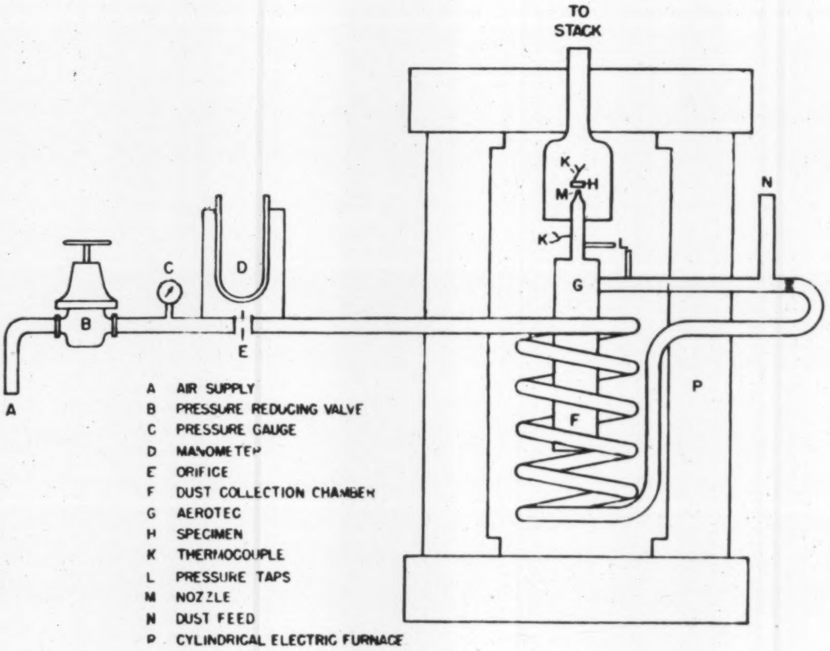
This paper describes the techniques used and the results obtained in an investigation of the erosion of metals by the impingement of fly ash.

One of the chief difficulties anticipated in the use of pulverized coal as a fuel for the gas turbine is the possibility of serious erosion of turbine blades and other metal parts by the suspension of fly ash in hot combustion gases. The Locomotive Development Committee of Bituminous Coal Research, Inc., has been vitally concerned with this problem in connection with the development of a coal-fired gas-turbine-driven locomotive. This Committee has therefore sponsored the work which is described, and which was carried out in the laboratories of the Institute of Gas Technology.

The erosion of metals through the impingement of solid particles suspended in a rapidly moving gas stream is an extremely complicated process which cannot at present be described in exact terms. It appears likely that, in most practical cases, erosion can take place through several different mechanisms, depending on the properties of the eroded material and of the impacting particle, as well as on local conditions at the microscopic point of impact.

The high operating temperature of gas-turbine blades introduces special problems in connection with erosion by solid particles. The oxide film which is formed on metal surfaces at high temperatures may well be more brittle and more susceptible to erosion damage than the underlying metal. If surface film is removed by erosion, exposing more metal to oxidation, then the repetition of this process might lead to a very rapid loss of metal. In addition, the heterogeneous nature of some turbine alloys complicates the situation because the relatively minute particles of fly ash may show a preferential attack on some constituents of the metal structure, resulting in the weakening of stressed parts. In studying the erosion of turbine blades by fly ash at high temperatures, it is thus necessary to investigate possible structural changes and localized damage, as well as the over-all loss in metal weight.

Since preliminary information was urgently needed on the probable course of erosion by fly-ash particles, experiments were designed to simulate turbine conditions as closely as possible. At the same time, the experimental apparatus was kept as simple and as flexible as possible, so that a rapid survey could be made of the chief variables which will determine the amount of erosion by fly ash in a coal-burning gas-turbine locomotive. In general, it appears that erosion can be controlled, but careful attention is required to several factors which were not previously known to be important.



APPARATUS FOR FLY-ASH EROSION TEST AT HIGH TEMPERATURE

Turbine-Nozzle Testing

Reaction Tests of Turbine Nozzles for Subsonic Velocities, by Hans Kraft, General Electric Company, Schenectady, N. Y. 1948 ASME Annual Meeting paper No. **48—A-59** (mimeographed).

A large number of turbine nozzles were tested by means of measuring the jet reaction. The results permit a study of the effect of most of the variables that play a role in turbine design. The design of the flow elements of turbines, whether they be considered as passages or as profiles, always involves a number of compromises between conflicting characteristics. Efforts due to changes in the form of the nozzle partitions, their angle, their spacing, their length (called radial height), and their exit edge thickness are shown.

The tests were made during the years 1920–1928. They are presented for the record together with some philosophizing as to their meaning in the light of modern aerodynamics.

Before the test results described in this paper became available the true characteristics of the velocity coefficient with spouting velocity, nozzle size, etc., were in doubt. So much so that mistaken ideas of these characteristics led to extremes in impulse-turbine design with, in some cases, both too many and too few stages. Costly mistakes could be avoided once the true characteristics were known.

It should be of interest to all concerned to see in retrospect how, without the help of a well-developed aerodynamic discipline it was, nevertheless, possible to obtain improvements in performance which, even today, it is hard to exceed.

Today's turbine nozzles are different in appearance from those presented here. The trend toward higher pressures and temperatures made them much stronger and competitive effort bettered their performance. They have, however, evolved gradually, not to say naturally, from these early specimens.

The results of the experiments are shown in the form in which they were obtained as are also the conclusions drawn at that time.

A short discussion is added which attempts to explain how the results fit themselves into the modern aerodynamic picture of lattice performance.

Reaction Tests of Turbine Nozzles for Supersonic Velocities, by J. H. Keenan, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1948 ASME Annual Meeting paper No. **48—A-61** (mimeographed).

A machine for testing turbine nozzles by the reaction method, which was described in the ASME Transactions, vol. 48, 1926, pp. 33–64, was used to test a series of convergent-divergent turbine nozzles. The results of these tests, along with the test of a convergent turbine nozzle, are compared with each other and with analytical values.

Two kinds of analytical values are employed: the first, the usual values obtained from an assumed isentropic expansion from inlet state to exhaust pressure; the second, values obtained from the assumption that the processes in the nozzle are isentropic except for a normal shock which takes up a position in the nozzle such as to cause the stream to fill the exit area at the exhaust pressure whenever possible. This latter kind of analytical value involves no shock when the exit area can be filled at the exhaust pressure by means of isentropic processes only, or when the exhaust pressure is lowered so far that the shock has passed out of the passage.

The agreement of the test results with the calculated results of this latter kind is good, and the disagreement that exists can be largely attributed to separation at the shock and to transmission of exhaust-pressure effects upstream through the boundary layer.

Steam Turbines

Steam Turbines for Resuperheat Cycle, by E. E. Parker, Mem. ASME, General Electric Company, Schenectady, N. Y. 1948 ASME Annual Meeting paper No. **48—A-58** (mimeographed).

Initial temperatures of 900 and 950 F are common for central-station service and a large amount of capacity is being installed at 1000 and 1050 F. It appears likely that operating experience with materials at 1000 and 1050 F will characterize the progress in central-station trends during the next few years. Such consolidation of experience need not, however, at the moment impede the progress in construction of stations for higher thermal efficiency. By application of the resuperheat cycle at 1000 F, plant heat rates can be achieved which in all probability will equal those possible in the future at initial temperatures of 1150 or 1200 F without the use of resuperheat. Thus the present renewed interest in and use of the resuperheat cycle parallels in many respects the conditions that led to its application 25 years ago.

Available records indicate that there is installed in the United States approximately 2,460,000 kw in turbine capacity for the interstage resuperheat cycle. In addition, available records show there is installed some 120,000 kw in noncondensing turbine capacity which supply steam to older low-pressure units with provisions for resuperheating the steam between the exhaust of the newer noncondensing turbines and the inlet to the older low-pressure units. This paper is limited to consideration of those turbines built for interstage resuperheat, that is, turbines built to utilize the steam from the throttle to the condenser.

An indication of the renewed interest in the resuperheat cycle can be attained from the fact that G-E now has under construction and on order at the middle of 1948 approximately 1,500,000 kw at nameplate rating for the interstage resuperheat cycle. The first of these units will be placed in service in 1949.

According to the paper, for steam-electric stations, the use of the resuperheating cycle permits the construction of new generating units with station heat rates 4 to 5 per cent lower than nonreheat installations at the same temperature and pressure levels.

From a turbine standpoint, the resuperheat cycle not only considerably reduces the number of stages in the moisture region, but also reduces the moisture content in those few stages remaining in this region. The elimination or reduction of moisture on turbine steam-path parts increases the useful life of these parts.

Recent improvements in equipment for this cycle have been made to reduce the capital investment and to more completely insure operating performance comparable to nonreheat units.

Machine Design

Engineering Problems in the Design of Heavy Mining and Process Machinery, by Fred R. Gruner, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1948 ASME Annual Meeting paper No. **48—A-71** (mimeographed).

This paper points out that increased costs of labor and lower grade of ore deposits will require advanced machine-design techniques if basic raw materials are to be mined and processed economically. This will be accomplished by functional design, automatic controls, better knowledge and application of materials for structural and abrasion-resistant purposes. Advanced mechanical-engineering problems in vibration analysis, critical speeds, fatigue, and materials application are encountered on many types of mining machinery.

In the mining of iron, copper, and other ores much greater tonnage will be handled by mining machinery for a given output of concentrate as compared to the period before World War II because of the remaining lower-grade deposits. In addition, the demand has increased tremendously. The cost of labor has practically doubled in the past six or seven years. This is true of mining labor and manufacturing labor as well. These rising costs are reflected in higher first costs right through the whole mining operation.

These high costs mean the following: (1) Mining machinery must be as efficient as the best standards of functional design can make it. This can be expressed in horsepower-hours or kilowatthours per ton or any other way, but the prime object is to mine ore at the lowest costs. (2) Maintenance and repair costs must be kept at a minimum. (3) Experience has proved that automatic controls increase operation efficiency and decrease labor costs when intelligently applied. Therefore more complete automatic control is now a very definite requirement. An example of the application of continuous automatic control is in the chemical industry. A visit to one of the large modern plants will amaze the observer by the absence of personnel. While the mining industry cannot be "instrumented" to such a high degree, it can profit by this example. It is the responsibility of machinery manufacturers in coöperation with operators to build equipment adaptable to automatic control wherever possible.

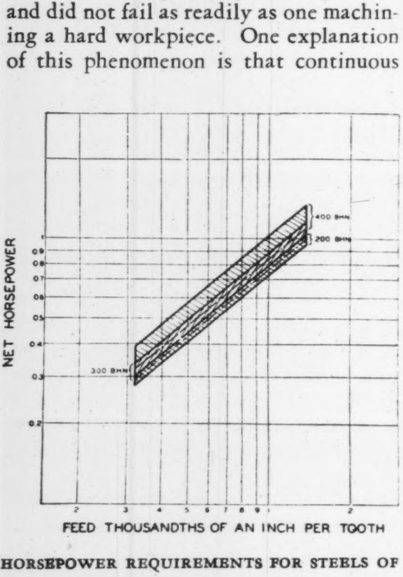
The mechanical design as applied to the mining industry is discussed in detail.

Metal Cutting

Influence of Steel Hardness in Face-Milling, by J. B. Armitage, Mem. ASME, and A. O. Schmidt, Mem. ASME, Kearney & Trecker Corporation, Milwaukee, Wis. 1948 ASME Annual Meeting paper No. **48—A-30** (in type; to be published in Trans. ASME).

Seven different kinds of steels were tested for power consumption and tool life at hardnesses of approximately 200, 300, and 400 Bhn. Differences in power required at any given hardness were comparatively small but the differences in tool life were more noticeable. Tool life was practically zero when the 400-Bhn test pieces were milled at 428 fpm cutting speed, the same speed as used on 200-Bhn test bars. However, a decrease in the cutting speed to 130 fpm and in the feed to 0.0045 ipt caused an increase in the tool life to a good performance when milling test pieces of 400 Bhn.

After machining a steel workpiece of 200 Bhn for some time, the power increased because of tool wear and was frequently higher than that used by a new tool cutting a much harder workpiece. However, a cutter operating on a softer material generally held up better and did not fail as readily as one machining a hard workpiece. One explanation of this phenomenon is that continuous machining must have worn the cutter in such a way that its shape was stronger, or that originally there were no weak spots or fine cracks in the blade which might have caused early failure.



HORSEPOWER REQUIREMENTS FOR STEELS OF DIFFERENT HARDNESS

The machining of hard alloy steels is still a major problem. It requires a powerful rigid machine, such as is available only in the latest models, and also a cutter able to withstand high cutting forces, a large number of heavy impacts per blade, and designed in such a way as to eliminate chip interference. Machining the workpiece at an elevated temperature was found to decrease the power required and permit good cutter life.

Textile Industry

The Present Status of Bonded Fabrics, by R. B. Seymour, Johnson and Johnson, New Brunswick, N. J., and George M. Schroeder, H. H. Frede and Company, Chattanooga, Tenn. 1948 ASME Annual Meeting paper No. **48—A-65** (mimeographed).

The recent development of several commercial processes for the production of plastic-bonded cellulosic web textiles has stimulated much interest in the textile industry. Some technologists are pessimistic about its future but many others are interested in knowing the possible effect of this process on the textile industry and what can be done to develop better machinery, tests, and more suitable applications.

One process that has found wide acceptance uses a blend of cellulosic and thermoplastic fibers such as cellulose acetate, Vinyon, and polyvinyl ether fibers. The lap is passed through heated rolls or cans in order to soften the thermoplastic fibers which serve as the binder. Some hats are made in a similar manner by using wool and Vinyon fibers. It is also possible to use solvents to soften the thermoplastic fibers but such a process is expensive and not readily adaptable to mill operations. When cellulose acetate is used as the secondary fiber, it can be saponified to cellulose after it has served as the bonding agent.

The final form of bonded fabrics made from fiber blends depends to a large extent on the secondary fiber and the temperature and pressure used in the bonding operation. It may resemble either cloth or paper, and unless the thermoplastic nature of the secondary fibers is altered, the heat-sealing properties may be utilized for the formation and sealing of packages for tea or silica gel. Laboratory experiments have indicated that almost any thermoplastic fiber may be used, although it may be necessary to admix a plasticizer in order to simplify the welding process.

In another general process, the bonding agent is added as a melt solution or emulsion using specific conventional equipment.

The Instron Tensile Tester, by Harold Hindman, Instron Engineering Corporation, Quincy, Mass. 1948 ASME Annual Meeting paper No. **48—A-68** (mimeographed).

This instrument is designed to measure accurately the load-elongation properties of such materials as textile fibers, yarns and fabrics, plastic films, adhesives, paper, rope, leather, and similar fibrous and nonfibrous specimens. By combining the features of an absolutely controlled rate of elongation with a precision electronic weighing system, an instrument has been developed for determining the properties of materials under tensile loading with an accuracy heretofore unobtainable.

The pulling jaw of the instrument is operated vertically by means of twin screws especially designed to eliminate backlash. The main power to activate the pulling head is derived from a servo-controlled amplidyne drive acting as a "positional follow-up" system.

The heart of the load-recording system consists of a sensitive pickup, based on the electric-strain-gage principle. The resulting electrical signals are amplified and made to operate a high-speed Leeds and Northrup Speedomax graphic recorder.

A choice of jaw speeds is provided from 0.05 to 20 in. per min in eleven steps.

Additional controls are available, as accessories, allowing an extremely reproducible return of the crosshead to a preset gage length.

Railroads

Protection of Lading and Equipment, by P. W. Kiefer, Mem. ASME, New York Central System, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-76** (mimeographed).

This paper describes and illustrates certain features embodied in the lot of New York Central System steel-sheathed box-type cars. It outlines their intended functional characteristics; and presents sufficient representative data from actual road tests, as recorded by means of a reliable method of instrumentation and procedure, to show the extent to which the lateral and vertical shocks of operations have progressively been reduced within the last three years, for elevated degrees of both lading and equipment protection, especially at the higher speeds with reduction to practice under these cars.

The principal betterments incorporated in this lot of box-type cars consist of the following: (1) Improved trucks of then available and new designs for progressively higher degrees of protection against the lateral and vertical shocks of operation; (2) high-speed pneumatic brake equipment combined with the necessary higher-ratio nonload compensating rigging; and (3) a double-acting cushioning device installed back of the couplers.

The car bodies themselves are of the AAR Standard design, carbon-steel-riveted, which, for this form of structure, is the best yet produced for interchange service on the American railroads, although for the past decade no comprehensive or conclusive studies have been made for the establishment of an improved AAR standard construction, with due regard for materials, methods of fabrication, and the use as desired, of approved competitive and fully interchangeable features such as doors, ends, roofs, and other items. It should be remembered, however, that a number of fundamental features of the present AAR standard design are used in all of the high-tensile low-alloy steel-welded or otherwise modified boxcar-body constructions offered by the different builders during recent years.

Traffic Considerations Leading to the Establishment of High-Speed Freight Service and Related Operating Problems by F. N. Nye, New York, N. Y., 1948 ASME Annual Meeting paper No. **48—A-78** (mimeographed).

Freight traffic provides more than three quarters of all operating revenues. It makes the principal and frequently the only contribution of net income. Less than carload business, while only about 2 per cent of total freight tonnage, is of great importance because it contributes a much higher percentage of freight revenues. This is particularly true for the New York Central whose 11,000 miles of line traverse eleven states producing two thirds of the nation's manufactures and containing one half the nation's population. Changing trends in our economy—decentralization of industry and the increasing production of consumers' goods—suggest that its importance will increase.

The motor carriers are the principal competition for this merchandise traffic. Their service is good and their rates attractive. Their business is now at record levels. They seek the cream of the business, moving in quantity lots, and are not averse to the railroads carrying the less attractive "balloon" freight and the small lightweight shipments. The only way the railroads can effectively combat this erosion of tonnage—particularly the more worth-while tonnage—is to give an improving standard of service. It is essential to retain and develop volume as a basis for efficient LCL operation. With diminishing volume unit, costs increase. Car lines must be canceled or run light and freight routed through transfers. Another factor to consider is that good LCL service has advertising value and sets the tone for the entire freight operation. It has a significant influence on carload routing. Last year the New York Central grossed approximately $47 million from its LCL operation—nearly 10 per cent of its total freight revenues—and far more than was received from mail and express combined or from any commodity or group of related commodities, except coal and "manufactures and miscellaneous." This traffic is worth our best efforts, and much planning and work through specialized transportation and traffic groups is now being devoted to it.

Granted adequate rates reflecting the specialized nature of the complete service, and with careful planning and efficient operation, this traffic, it is believed, can be made to return full costs and yield a fair return on that portion of the railroads' investment in road and equipment devoted to its handling.

Rubber and Plastics

Frictional Characteristics of O-Rings With a Typical Hydraulic Fluid, by La Verne E. Cheyney, William J. Mueller, and Robert E. Duval, Battelle Memorial Institute, Columbus, Ohio. 1948 ASME Annual Meeting paper No. **48—A-64** (mimeographed).

O-ring packings employed in aircraft hydraulic systems are subject to numerous operating variables which affect the friction involved in their operation. A method for studying the friction is described and the effects of several variables—pressure, time delay, squeeze, stroke speed, ring size, and surface finish of the moving metal part—have been determined.

During the past several years there has been a strong trend in the aircraft industry toward the use of hydraulic systems, as a result of increases in the size of airplanes, where the required forces prohibit manual operation of many controls. The hydraulic system has an advantage over other possible systems because it assists in the movement of controls, but it still maintains the "feel" which is considered highly desirable.

Among the very small but very important parts of a hydraulic system are the packings. Earlier systems in use for aircraft employed one or more of the well-known V-ring, U-cup, or compression-type packings. The O-ring is a fairly recent development in the packing field, which has been shown to have many advantages over the older types.

To prevent sticking of moving parts and excessive wear on packings, the friction between the moving parts and the packing should be held to a minimum. It would be expected that the early compression-type packings would cause high friction because of their design. O-rings offer an opportunity to reduce this friction because of a much smaller area of contact with the moving part.

Hydraulics

Pipe Factors for Quantity Rate Flow Measurements With Pitot Tubes, by R. G. Folsom and H. W. Iversen, University of California, Berkeley, Calif. 1948 ASME Annual Meeting paper No. **48—A-35** (mimeographed).

The quantity rate of flow of a fluid in a pipe may be determined by a large variety of methods. The use of a Pitot tube (an instrument to determine the average velocity over a small area of the test cross section) in the velocity-area method provides an example of an important practical application. In order to develop the accuracy and convenience of quantity rate of flow measurements by Pitot tubes, the Department of Engineering of the University of California, in co-operation with the National Association of Vertical Turbine Pump Manufacturers, has initiated an investigative program. This report presents the results of studies on the "pipe factor" method of measurement.

A method for quantity rate flow measurements in a commercial pipe by means of the pipe factor and a Pitot tube reading at a single position has been developed. The accuracy of the method is a function of the Reynolds number, position of the Pitot tube, the relative roughness of the pipe, and the geometry of the piping system.

The comparison of calculated and experimental pipe factors is not conclusive because most of the available published articles do not specify all of the independent variables. The preliminary results indicate that the pipe factor and center-line velocity may be applied with an expected error of less than ±3 per cent in the flow measurement when sufficient lengths of straight pipe are available. It is possible that controlled experimental investigations will indicate a greater degree of reliability for the method.

Speed-Regulation Computations for Hydraulic Turbines, by Robert Lowry, consulting engineer, Upper Darby, Pa. 1948 ASME Annual Meeting paper No. **48—A-37** (mimeographed).

The approximate formulas used in the past to calculate speed-regulation values for hydraulic turbines have been based on an average horsepower or average torque during the control procedure. Secondary influences have usually been neglected, such as specific speed, runaway speed, and position of gates at no load. These factors may tend to compensate each other to some extent.

A comparison between the dual regulation on Pelton turbines and the Kaplan-turbine regulation which have similar control procedures and require special speed-regulation computations is also given.

The guarantee for the speed change of hydraulic turbines is usually determined for loads thrown off of 100, 75, 50, and 25 per cent of rated capacity, and for sudden loads thrown on of 75, 50, and 25 per cent of rating.

This paper develops a method to calculate such speed changes. For preliminary studies, when only the general behavior of the runner is known, a simplified table is given. The exact checking of field tests can be done if necessary by a step-by-step procedure whereby all factors of influence can be duly introduced. This procedure is precise but needs considerable time. The method discussed presents a short way to make possible a checking of field tests without lengthy integration.

Education

What Can the Machine-Design Field Expect From the Recent College Graduate, by C. H. Young, Mem. ASME, The Cooper Union School of Engineering, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-72** (mimeographed; to be published in MECHANICAL ENGINEERING).

One hundred thirty-three engineering schools throughout the country are graduating more than 5000 men each year and will probably continue to do so until 1950, according to reports of the American Society for Engineering Education.

About 15 to 20 per cent of the engineer's time in college has been spent on subjects of the socio-humanistic stem, the remainder on the technical stem, or the engineering part of his education. The emphasis in all his learning has been on logical thinking and problem analysis. The college has educated him, now he is ready to be trained. This well-rounded graduate can step into any mechanical-engineering job as a trainee and give a creditable performance.

Furnace Performance Factors

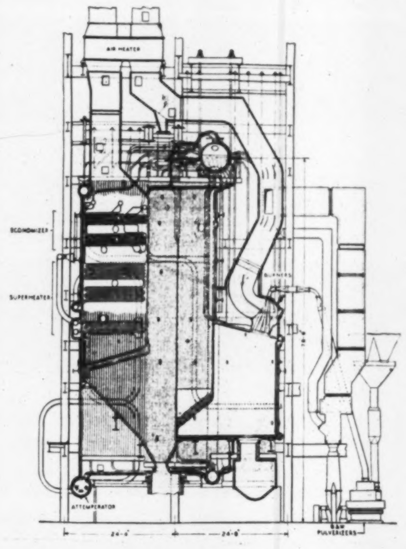
Southwark Station Boiler Air-Flow Model Tests and Operation Results, by R. A. Lane, Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa., and E. L. Morrison, The Babcock & Wilcox Company, New York, N. Y. 1948 ASME Annual Meeting paper No. **48—A-26** (in type; to be published in Trans. ASME).

This paper discusses the engineering application of scale-model study of the combustion-air distribution for a proposed boiler installation. By obtaining an intimate mix of fuel and air, a more nearly uniform and nonreducing atmosphere results in the furnace to avoid the phenomenon of tube wastage. Following the operation of the prototype boilers, field tests were made for direct comparison with the model results. These comparisons, the actual combustion-gas analyses, and the boiler performance are reviewed.

Operating experience with the boilers showed that some coking occurred on the end burners, which may be attributable to a lower air velocity. In the early model tests it was noted that the velocity at the front and rear of the burner ports dropped sharply due, presumably, to the frictional drag of the adjacent surfaces.

Primary-furnace observations indicate that the ignition point is close to the burner ports. The flame issuing from the burner is essentially normal to the furnace-roof tubes, and of similar direction to the path observed on the model. Observations indicate the flame to be very luminous, free from smoke tails, and with well-defined boundaries over a wide range of loads, coal conditions, and with various numbers of burners in service.

After several months of operation, the primary-furnace walls were covered with a smooth uniform thickness of slag having no well-defined or discernible pattern, nor is there any tangible evidence of tube wastage.



SECTIONAL SIDE VIEW OF SOUTHWARK STATION BOILER

Gas-Turbine Parts Testing

Mechanical Investigations of Gas-Turbine Components, by Carl Schabtach, Mem. ASME, General Electric Company, Schenectady, N. Y. 1948 ASME Annual Meeting paper No. **48—A-47** (mimeographed).

This paper presents the nature of and gives the significant results of tests of gas-turbine parts to determine bursting strength of turbine and compressor wheels, fatigue strength of compressor blades, deflection and stress in nozzle diaphragms, resistance to fluctuating thermal stresses, tensile strength of dovetail attachments, rotor critical speed, and other design criteria.

The mechanical features of gas and steam turbines are sufficiently alike so that the gas-turbine designer may profitably draw on the rich heritage of steam-turbine experience available to him, yet sufficiently different so that he may wisely choose to check the mechanical design of certain components by suitable tests. This paper describes such tests performed on components of a gas turbine for locomotive drive, the general features of which were presented in MECHANICAL ENGINEERING, April, 1948, p. 301. The unit embodies a 15-stage axial-flow compressor, six combustion chambers, and a two-stage turbine, all arranged in line for straight-through air flow.

Graphitization of Steel Pipe

Further Investigation on the Graphitization of Piping for the EEI and AEIC, by A. M. Hall and S. L. Hoyt, Battelle Memorial Institute, Columbus, Ohio. 1947 ASME Annual Meeting paper No. **47—A-139** (in type; published in Trans. ASME, November, 1948, p. 847).

The graphitization test program was initiated in 1943 at Battelle Memorial Institute by the EEI and AEIC.

This paper gives the results of further investigation of the graphitization of steel piping carried out during 1947. Additional experience with some of the more resistant types of steel (carbon-molybdenum, chromium-molybdenum, and vanadium-molybdenum) compositions was obtained as well as further information bearing on the question of the incubation period.

In addition, another effort was made to establish a relationship on a laboratory basis between the graphitization phenomenon on the one hand, and plastic deformation such as might occur during the installation of a pipe system, on the other hand. In a previous attempt, plastic deformation prior to the graphitization test had been produced by compression (upsetting). In the present study, deformation was accomplished by stressing in tension. The matter is important because it bears on those disturbing special cases of severe segregated graphite formation not associated with welding but apparently related to deformation phenomena, such as Lüders lines.

Finally, another type of continuous graphite formation is reported where the segregation did not occur in a weld-heat-affected zone.

A Study of the Properties of 0.5 Per Cent Chromium—0.5 Per Cent Molybdenum Pipe Steel, by R. C. Fitzgerald, Consolidated Gas Electric Light and Power Company of Baltimore, Baltimore, Md., A. B. Wilder, National Tube Company, Pittsburgh, Pa., G. V. Smith, U. S. Steel Corporation, Kearny, N. J., and A. E. White, Fellow ASME, University of Michigan, Ann Arbor, Michigan. 1947 ASME Annual Meeting paper No. **47—A-173** (in type; published in Trans. ASME, November, 1948, p. 867).

Study of the mechanical properties, including creep, and of the welding and fabrication characteristics of steel containing 0.5 per cent chromium and 0.5 per cent molybdenum, designed for elevated-temperature service, has shown this grade to be essentially similar to 0.5 per cent molybdenum steel without chromium. However, elevated-temperature exposure tests have shown the steel, whether deoxidized with aluminum or not, to be resistant to graphitization in butt-welded pipe as well as bead-weld tests lasting up to 15,000 hr at 1025 F and 12,000 hr at 1100 F. Scaling tests and hardness and notch-impact tests before and after air exposure at elevated temperature have indicated that only slight oxidation and little or no embrittlement may be anticipated during service of this grade of steel.

The Structural Stability of Several Cast Low-Alloy Steels at Elevated Temperatures, by V. T. Malcolm and S. Low, Mem. ASME, The Chapman Valve Manufacturing Company, Indian Orchard, Mass. 1947 ASME Annual Meeting paper No. **47—A-174** (in type; published in Trans. ASME, November, 1948, p. 879).

The effect of temperature on several cast low-alloy steels has been investigated in the laboratories of The Chapman Valve Manufacturing Company. ASTM A217-46T Grade WCI, and modifications of this composition, were surveyed thoroughly. The following variables are investigated with respect to structural stability: (1) The effect of aluminum on a cast carbon-molybdenum steel; (2) the effect of furnace practice on a cast carbon-molybdenum-vanadium steel; (3) the effect of chromium on a cast carbon-molybdenum steel; (4) the effect of vanadium on a cast carbon-molybdenum steel; (5) the effect of various combinations of chromium, vanadium, and titanium on a cast carbon-molybdenum steel; and (6) the effect of chromium, nickel, and high molybdenum on a cast carbon-molybdenum steel.

The physical properties of the alloys investigated are given in detail. Data are presented on the results of McQuaid-Ehn, tensile, Jominy hardenability, creep, and weldability tests. Photomicrographs are used to illustrate structural stability after various aging cycles. New work is presented to illustrate the effect of aging at elevated temperature on static bend bars and V-notch Charpy bars.

ASME Transactions for November, 1948

THE November, 1948, issue of the Transactions of the ASME contains the following papers:

- Further Investigation on the Graphitization of Piping for the EEI and AEIC, by A. M. Hall and S. L. Hoyt (Paper No. 47—A-139)
- Some 1000 F Steam-Pipe Materials, by E. L. Robinson (Paper No. 47—A-74)
- A Study of the Properties of 0.5 Per Cent Chromium—0.5 Per Cent Molybdenum Pipe Steel, by R. C. Fitzgerald, A. B. Wilder, G. V. Smith, and A. E. White (Paper No. 47—A-173)
- The Structural Stability of Several Cast Low-Alloy Steels at Elevated Temperatures, by V. T. Malcolm and S. Low (Paper No. 47—A-174)
- Theory and Practice of the Crush-Dressing Operation on Grinding Wheels, by E. C. Helfrich (Paper No. 48—SA-42)
- An Evaluation of Cylindrical-Grinding Performance, by R. E. McKee, R. S. Moore, and O. W. Boston (Paper No. 48—SA-9)
- Heat Transfer Through Thick Insulation on Cylindrical Enclosures, by T. S. Nickerson and G. M. Dusinberre (Paper No. 47—A-63)
- Condensation on Six Finned Tubes in a Vertical Row, by D. L. Katz and J. M. Geist (Paper No. 47—A-96)
- Stability of SR-4 Electric Strain Gages and Methods for Their Waterproofing and Protection in Field Service, by A. Boodberg, E. D. Howe, and B. York (Paper No. 47—A-120)
- Oscillating-Piston Meters for Fuel Consumption in Aircraft, by C. S. Hazard (Paper No. 47—A-54)
- High-Temperature Performance of Silicone Fluids in Journal Bearings, by J. E. Brophy, J. Larson, and R. O. Militz (Paper No. 47—A-114)
- Problems Associated With Use of Diesel Fuels, by W. L. H. Doyle and E. W. Landen (Paper No. 47—A-124)
- A Method of Correlating Axial-Flow-Compressor Cascade Data, by Hunt Davis (Paper No. 47—A-81)
- Fluid Devolatilization of Coal for Power-Plant Practice, by A. D. Singh and L. J. Kane
- Ball-Bearing Slides, by Conrad Jobst (Paper No. 47—A-42)
- Analysis of Heat Transfer Over a Small Cylinder in Icing Conditions on Mount Washington, by Myron Tribus, G. B. W. Young, and L. M. K. Boelter
- Limitations and Mathematical Basis for Predicting Aircraft Icing Characteristics From Scale-Model Studies, by Myron Tribus, G. B. W. Young, and L. M. K. Boelter

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Engineering and the Medical Sciences

COMMENT BY PAUL F. WOOLRICH[1]

Although "the Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications," the writer feels that those employed as sanitary engineers have a legitimate "gripe" with regard to a recent paper by Mr. Luis de Florez.[2]

For years engineers trained in the science of sanitary engineering have been active in "preventive disease," yet the author fails to recognize the service of the engineer beyond the construction of a few simple gadgets for checking pulse rate, and the like. He states: "So far, engineers have not played much part in helping medical men in their war on disease, however, it may be remembered that engineers and physicists were called upon during the war to assist in developing better prosthetic devices." If that is the sum of the engineer's service to prevention of disease, it certainly should not, in the writer's opinion, be publicized in technical journals for all to see the engineer's lack of concern and effort for this science.

In this state where polio runs rampant during summer months, the sanitary engineer perhaps does more toward curbing epidemics than any other scientific group. The typhoid rate in the writer's state (as in others) has been reduced from 9.9 per 100,000 in 1933, to 0.4 per 100,000 in 1947. The engineer built the water-treatment plant and instigated anti-stream-pollution measures, built sewage-treatment plants, etc., to curb this disease.

The author even says that the Panama Canal could not have been built without medical control of disease. True, the medical men were on hand to treat cases of yellow fever, but the engineer should get credit for eliminating the *Aedes aegypti* mosquito in the Canal Zone through engineering controls of drainage, spraying, etc.

Activities of sanitary engineers during the last war proved indispensable in control of communicable diseases throughout the world. What about control measures in Italy, Africa, South Pacific, etc., where before arrival of sanitary engineers, morbidity reports from communicable diseases were higher than those from combat wounds? In the South Pacific, sanitary engineers were often in first-wave landings to establish beach heads and control disease. Statistics on these activities can be obtained from Colonel W. A. Hardenbergh, president and editor, *Public Works Magazine*, New York, N. Y., who was Chief, Sanitary Engineering Division, Sanitary Corps, Medical Department, U. S. Army.

AUTHOR'S CLOSURE

I regret that anything in my speech which was reproduced in the August issue of MECHANICAL ENGINEERING should have been taken as either a slight or lack of appreciation of the work done by the sanitary engineers.

The work of the sanitary engineers is obviously directed toward the maintenance of health and the improvement of living conditions—and their record speaks for itself.

My remarks were directed at the vast group of engineers and scientists who have no direct connection with medicine but who through their training, knowledge, and experience could contribute so much to the advancement and acceleration of research to fit the human being to cope with the physical and mental problems of the future.

That the typhoid rate in the State of Texas has been reduced as Mr. Woolrich points out to 0.4 per 100,000 is a great achievement. Some of it, however, must be ascribed to inoculations which are the result of research. No doubt, the state will improve conditions to reduce the scourge of polio, yet it is reasonable to believe that, with the added skill and drive in research which would result through enlisting the interest and efforts of the engineering profession as a whole, a vaccine or serum might become available sooner to check the disease as effectively as vaccination has stamped out smallpox.

It is hoped that my remarks can be viewed, as intended, not as a criticism or slight but construed as an appeal for more intimate contact and cooperation between those of the medical profession and the thousands of technically trained and experienced engineers and scientists who can contribute some part of their knowledge and skill toward the war on disease and to fit the human being to cope with the ever-increasing field of human activities.

LUIS DE FLOREZ.[3]

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[1] Sanitary Engineer, Texas State Department of Health, Austin, Tex. Jun. ASME.

[2] "Engineering and the Medical Sciences," by Luis de Florez, MECHANICAL ENGINEERING, vol. 70, August, 1948, pp. 661–665.

[3] President, de Florez Engineering Company, Inc., New York, N. Y. Mem. ASME.

Welded Joints

TO THE EDITOR:

As reflecting the accumulated observations of an insurance-company engineer, Mr. E. B. Lund's letter[4] deserves the careful consideration of every engineer concerned with welded construction. The point that welded joints are liberally rated in the Boiler and Pressure Vessel Codes, by a reduction of a mere 5 to 15 per cent in effective allowable stresses, as compared with seamless construction, is well taken. Also the statement that "the percentage of radiographed welds which are found to be unsatisfactory in boiler and pressure-vessel construction is surprisingly high" should give pause to those who wish to uprate welded longitudinal joints in pressure vessels so as to make them fully equal to seamless material.

While we agree with the objective of Mr. Lund's letter, it is our impression that the facts offered in support of his contention may be misleading. We are not familiar with the tests referred to in the fifth paragraph of his letter, but would assume from the low values given for butt welds that the comparison of the fatigue strength of butt welds with that of the base material is based upon small polished specimens for the base material and possibly some different type of specimen for the butt welds. We are led to this belief by the widely divergent results which have been obtained in fatigue tests on commercial pipe in the state in which it is used, which have been conducted by the research department of the company with which the writer is associated.

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[4] "Welded Joints," letter to the editor, by E. B. Lund, MECHANICAL ENGINEERING, vol. 70, July, 1948, p. 637.

As part of the first phase of a comprehensive testing program intended to encompass all forms of commercial piping components, this organization has carried out fatigue tests on 4-in. standard-weight welding elbows in comparison with miter bends.[5] In the evaluation of the test results it was noted that the experimentally determined stress-intensification factors for the elbows were of the order of 45 to 60 per cent of the controlling stress-intensification factors predicted by theory, specifically that of Leon Beskin.[6] It was surmised that at least part of this quite consistent discrepancy might have been caused by inadequacy of the reference basis; pending tests of our own, the endurance strength of plain pipe (to which that of curved pipe was to be related by the stress-intensification factor) was taken from an earlier investigation published by Rossheim and the writer,[7] in which the specimens were mounted in an ordinary lathe.

To clear up this point, tests on straight pipe were recently initiated. The first test runs gave similar results to those shown in the source just cited, but it was felt that the means of clamping, despite precautionary measures, remained a significant contributor to the failures. After all means of lessening the notch effect of the clamping means had failed to accomplish the desired end, it was finally decided to procure 4-in. pipe of standard weight with one end (the anchorage end) very gradually swedged up to a thickness increased just sufficiently to assure failure within the section of uniform thickness. Tests with this arrangement evaluated to date showed consistently improved performance, the average life increasing to about 4 times that found in the earlier tests, corresponding to an increase in endurance strength of the order of 33 per cent.

By cutting sim[illegible] specimens a short distance ahead o[illegible]rt of the swedge, beveling and w[illegible] the two ends together by a butt[illegible]d, specimens for truly comparable [illegible]ts of butt-welded girth joints were obtained. Their fatigue strength closely agreed with that of clamped seamless pipe but was only about three quarters that of the unwelded specimens with no clamping effects.

Similar results were later obtained in a series of tests with welding-neck or butt-welding flanges to 300-lb ASA dimensions. These assemblies also showed about three-quarters of the endurance strength of seamless specimens tested under conditions closely approaching the ideal.

In other words, the stress-intensification factor of seamless unwelded pipe, not subjected to the adverse effects of clamping, could be considered as 0.75 with reference to clamped unwelded pipe, or its approximate equivalent, i.e., pipe with a butt-welded girth seam. We appreciate that it would be more logical from a theoretical standpoint to establish the seamless unclamped pipe as the basis for reference, and to assign a stress-intensification factor of 1.33 to clamped unwelded pipe, as well as to pipe with a butt-welded girth seam. However, for the practical purpose of piping design for flexibility, the reference point which we have chosen appears more satisfactory, since a stress intensification lower than that caused by clamping the pipe or butt welding it to another pipe apparently cannot be realized in ordinary assemblies, but produced only by special means restricted to laboratory investigations.

In any event, our tests appear to indicate that the endurance strength of circumferential butt-welded joints, representative of welds made by qualified operators, is theoretically of the order of three quarters that of seamless pipe; this contrasts with values ranging down from one third to one tenth cited by Mr. Lund. Moreover, since pipe is always attached to anchors or equipment by means introducing a measure of stress intensification at least equivalent to that of a butt-welded joint, there appears good justification for considering the endurance strength of butt-welded circumferential seams as equal to that of seamless pipe for all practical purposes.

A very definite distinction should, in our opinion, be made between pipe and pressure-vessel welding, as contrasted to structural welding; in the former case, welding conditions in general are vastly more favorable and at the same time inspection requirements are very much more searching than for the latter. Also, it should be remembered that the face, root, and side-bend tests required to qualify welding procedures and operators are quite severe and produce conditions which may not be even remotely approached in service.

With reference to riveted construction, we concur with Mr. Lund's statement that "the factors involved in the construction of a riveted joint are so greatly different from those involved in welded structures as to make a comparison between the two of little value." Accordingly, while the theoretical efficiency of a riveted joint can be calculated, it would be wrong to imply that the result could be directly compared with the efficiency of a welded joint. Riveted joints are known to behave poorly under cyclic conditions, which is one of the reasons why riveted construction has lost ground to welded construction in the design of slender steel stacks. It should also be remembered that riveted joints are subjected to no tests which would in any way parallel the face, root, or side-bend tests by which welded joints are judged.

In closing, we would venture the opinion that, for all applications where fluids have to be contained under pressure, and especially where cyclic bending stresses are involved, the order of preference may be expected to remain as follows: (1) seamless construction, (2) welded joints, and (3) riveted construction.

A. R. C. MARKL.[8]

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[5] "Fatigue Tests of Welding Elbows and Comparable Double-Mitre Bends," by A. R. C. Markl, Trans. ASME, vol. 69, 1947, pp. 869–879.

[6] "Bending of Curved Thin Tubes," by Leon Beskin, JOURNAL OF APPLIED MECHANICS, Trans. ASME, vol. 67, 1945, p. A-1.

[7] "The Significance of, and Suggested Limits for, the Stress in Pipe Lines Due to the Combined Effects of Pressure and Expansion," by D. B. Rossheim and A. R. C. Markl, Trans. ASME, vol. 62, 1940, pp. 443–464.

[8] Chief Research Engineer, Tube Turns, Inc., Louisville, Ky.

Digests of 1948 ASME Annual Meeting Papers

DIGESTS of available preprints of papers presented at the 1948 ASME Annual Meeting, held in New York, N. Y., Nov. 28 to Dec. 3, 1948, appear in this month's ASME TECHNICAL DIGEST, pages 1012–1021. The November issue of MECHANICAL ENGINEERING also contained digests of available 1948 Annual Meeting preprints, as will the January, 1949, issue.

This month's TECHNICAL DIGEST contains abstracts of papers covering such subjects as applied mechanics, gas turbines, steam turbines, metal cutting, education, process industries, machine design, furnace performance, fuels, heat transfer, oil and gas power, hydraulics, and railroads.

Pamphlet copies of the complete papers are available at 25 cents each to members; and 50 cents each to nonmembers from ASME Order Department, 29 West 39th St., New York 18, N. Y.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Trends in Engineering Education

TRENDS IN ENGINEERING EDUCATION, THE COLUMBIA EXPERIENCE. By James Kip Finch. Columbia University Press, New York, N. Y., 1948. Cloth $5^1/_2 \times 7^3/_4$ in. 140 pp., $2.

REVIEWED BY A. G. CHRISTIE[1]

THIS interesting little book should be read by everyone connected with American engineering education. Ours is a changing world and, as the author points out, American engineering schools must not only continue their traditional teachings but must also advance the frontiers of engineering science. Europe can no longer be expected to provide new ideas and data. Engineering education in America must be modified to meet these new and pressing demands. This book presents an analysis of the problems and a plan to meet the situation.

The content of an engineering curriculum will always be a debatable subject. The needs of American industry are many and varied. Different sections of the country have local needs which influence the teaching of their schools, particularly their state institutions. It is conceded that directors of production, road constructors, power-plant supervisors, maintenance-of-way men and others may not need the same rigid training as the engineering research specialist. But developments in engineering and technology so profoundly affect the daily life of the nation that it behooves the engineer to give greater consideration to the social impact of his creations and operations. In many cases this requires ability to interpret these to the general public in a simple readily understood manner.

Engineering curricula need modification by incorporating a liberalization in the form of better courses in English, a familiarity with the best of literature, an appreciation of our political organization, and of the historical background of our institutions. Can these added courses be provided and if so, what is the extent and content of the resulting curricula? Undoubtedly the privately endowed institutions have greater freedom in changing courses and in the selection of student body than the large state colleges. However, the maintenance of American preeminence in technology requires that every opportunity be given to the gifted man to develop his abilities to the utmost. His training must be planned to give him the best instruction in the world today.

The author discusses these considerations and presents the pioneering experiences of Columbia University in developing curricula to satisfy today's needs. Columbia was one of the first to liberalize its engineering curricula. The addition of the so-called cultural courses necessitated the displacement of certain specialized professional courses. Only basic engineering courses are in the four-year program. Professional courses in the several branches of engineering have been transferred to additional years of training.

Short concise chapters discuss the background of engineering education in America and at Columbia University. The general educational problem is next explored, followed by a discussion of the general plan of the undergraduate course and its conformity to today's requirements. The author next presents views on engineering science followed by a chapter on graduate instruction to train men in the further development of this science. New developments lead to inventions and patent policies are considered. Phases of the student problem at Columbia are presented under the headings of student guidance, scholastic standards, personality development and placement. The final chapters cover the problems of the graduate who needs additional instruction on his job and some educational contradictions.

All readers will not agree with Professor Finch for curricula forms a perennial subject of controversy. The author's vigorous and clear presentation of the problems and his account of one method of their solution will stimulate each reader and lead to the initiation of that progress in American engineering education which will meet present-day demands. America has become the world leader in engineering education. This position must and can only be retained by continued development and change.

American Shipbuilding Industry

THE SHIPBUILDING BUSINESS IN THE UNITED STATES OF AMERICA. Edited by F. G. Fassett, Jr. The Society of Naval Architects and Marine Engineers, 29 West 39th Street, New York 18, N. Y., 1948. Cloth $8 \times 10^3/_4$ in., vol. I, 313 pp., vol. II, 250 pp., illus., tables, charts, $12.50 per set postpaid U. S. A. Foreign postage $1.25 per set.

REVIEWED BY WILLIAM S. OWEN[2]

THIS is the third in a series of publications by the Society of Naval Architects and Marine Engineers: The first was a two-volume set, "Principles of Naval Architecture," published in 1939; the second, "Marine Engineering," was published in 1942 and 1944, respectively, for its two volumes. Both of these publications were well received by naval architects and marine engineers generally and are regarded as constituting a worth-while contribution to the literature on these subjects, being especially useful to students and others interested in the design and study of ships and their machinery.

This latest publication is unique in that it deals with the many varied aspects of the business of operating shipyards and marine repair plants. Vol. I contains an informative foreword by the president and six past-presidents of the Society of N.A.&M.E., and seven chapters with various subsections, each by an outstanding authority in his field, dealing with such subjects as the economics, history and development of the art, shipyard layouts and organization, labor, and wages, as concerned with shipbuilding. Vol. II has eleven chapters, likewise with subsections and authoritatively written on such subjects as proposals and contracts, planning designing, scheduling, production and control, storekeeping, cost estimating, accounting, marine insurance, classification societies' rules and government inspection for shipbuilding and ship repairing.

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[1] Past-President and Honorary Member ASME, Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md.

Another review of this book will be found in the "Junior Forum," page 1042 of this issue. —EDITOR.

[2] Dean, Webb Institute of Naval Architecture, Glen Cove, L. I., N. Y.

The shipbuilding industry of the U. S. A. has a right to be proud of its accomplishments in the two world wars, and the public at large should realize what a debt the country owes to the achievements of the relatively few men who were able to direct the vast shipbuilding programs that contributed so vitally to victory of the Allies—twice, in a span of twenty-eight years! In each case, gigantic problems were suddenly thrust upon an otherwise small and relatively inconspicuous industry in our land. During 1914 American shipyards had produced less than fifty new merchant ships and naval vessels, but four years later the annual output was about nineteen times as great!

A huge and rapid expansion of any industry is not conducive to efficient and orderly growth, but the great demands for merchant and war vessels in the emergencies overshadowed other considerations. Shipyards had to be built along with the needed ships, and skilled shipyard personnel was spread very thinly among the huge army of workers that had to be employed. The fact that so much was accomplished in so short a time speaks volumes for the productive ability of the shipbuilding industry, which in turn had to call upon the engineering talents of vast cross sections of American industry.

The shipbuilding accomplishments for World War II far surpassed those for World War I, great as those previous records were! Two things contributed vitally to this result, aside from the lessons painfully learned in the former emergency. One of these was the improvement in the application of electric-arc welding to shipbuilding, enabling large segments of ships' structures to be prefabricated on the ground and assembled and joined together quickly and effectively on the building ways, without having to depend on the much slower process of riveting. The other was the technical advances in marine engineering, whereby about double the horsepower could be installed in the same cubic space within a ship and on the same weight as formerly: This in large steam installations as well as in small Diesel machinery.

The story, the history, as well as surmises for the future with their political implications on the international policies of the U. S. A., as presented in these volumes constitute an informative, fascinating, and altogether worth-while survey of an industry, which cannot fail to interest not only those already connected by choice or circumstance with some one particular branch of shipbuilding, but also those with engineering and business responsibilities in other American industries.

Engineers, Builders of a Better World

INGENIEURE BAUMEISTER EINER BESSEREN WELT (ENGINEERS, BUILDERS OF A BETTER WORLD). By Friedrich Münzinger. Third German edition (in German). Springer Verlag, Berlin, Germany, 1947. Cloth $5^3/_4 \times 8^1/_4$ in., 263 pp., 17 figs., No price listed.

REVIEWED BY M. F. WULFINGHOFF[3]

THIS book, originally written less than ten years ago, constitutes a searching account of the status of engineering. The author's thesis is threefold. Firstly, engineers must more fully understand the influence of modern technology in all its ramifications upon society and its functions. Secondly, we cannot disregard with impunity certain limitations which technology imposes in exchange for others that existed in earlier periods and which it has removed. Thirdly, the applications of technology in general need to be guided by the same spirit which has permitted its amazing successes in specific endeavors, meaning the will to co-operate, logical thinking objectivity, and a striving toward steadily improved effects and their proper balance which is so conspicuously absent in the world at large. It is not the atomic bomb, or some other device, that jeopardizes our existence, but rather the utter lack of ethical and moral progress, as contrasted with that of science and technology. This lack is so obvious that Sir Thomas Beecham recently voiced the opinion that we are retrogressing into barbarism. Both individuals and nations today indulge in concepts and sentiments incompatible with the situation created by technological advances. The application of nucleonics, considered in itself, demonstrates an effective synthesis of engineering and science, backed by a brilliant organization and vast funds. Objectively considered, however, it constitutes a rather accidental link in the chain of technological development, comparable to the advent of the steam engine. The number of those is limited who perceive the two-faced nature of technology, and clearly see that the well-being or the doom of individuals and nations, possibly of all of our civilization, depends upon the spirit in which technology is applied. To those engineers who think that their duty ends with the furtherance of the production of some commercialized item of manufacture, Münzinger points out what John Dewey formulated thus: "If ever we are to be governed by intelligence, not by things and words, science must have something to say about what we do, and not merely about how we may do it more economically." The fundamentals of our economic age, the development of technology, its purposes, essence, and drawbacks are surveyed. The relations are analyzed between technology on the one hand and culture, science, nation, religion on the other. Switching to man as the central figure, the author discusses engineering training, the parts played by science, by experience, and by common sense; the significance of the time factor and of the element of risk; the role of the specialist; the uses of improved human relations and that of intuition and creative instinct. The case histories of several inventions are examined, and opinions of contemporaries and of later generations are compared, with interesting results. The consequences which follow in the wake of such innovations are outlined, such as increasing demand for mechanical power, expanded transportation, increased industrial and agricultural output, progress in hygiene and medicine, modernization of warfare, and stimulation of further research. The parts played by coal and oil in international politics are discussed, as is the problem of the production machine.

The significance of parentage, teaching, and associates in the career of the individual and the relative merits of hard work, knowledge, ability, health, character, and experience are discussed next. Other chapters deal with inventors and inventions, designers and design, the engineer's social status and recognition, causes of inadequacies and possible remedies, relations among engineers and between engineers and their principals. The book closes with an intriguing speculation on the hypothetical reaction of a member of a past generation called back to life and faced with our present technological achievements—and optimistic enough to expect ethical and humanitarian advances of proportional order. Such a visitor would find it hard to believe that today's account stands at 15 million lives recently lost in military encounters, 3 million dead by aerial bombardment, 16 million dead from secondary causes, augmented by 30 million injured, 22 million homeless, and 15 million displaced humans. He would be further troubled by the simultaneous existence of starvation in one part of this world, and willful destruction of food in another part; by spectacular efforts on behalf of individual victims of illness on the one hand, and the callous abandoning of large groups of humans to their fate on the other. Indeed, he might well be reminded of an infant playing with a bottle of lethal poison. Upon inquiry into the causes of this state of affairs, he might learn that there are a few basic ones: The close contact between nations enforced by technology; the resulting economical, political, and social upheavals; the absence of a common ideal; and finally the tremendously increased impact and range of action of armament. The last hundred years have seen a twenty-five-fold increase in imports and exports; relations between trading groups became correspondingly close, and every disturbance necessarily had far-reaching consequences. Inconsiderate rationalization within one group became a possible cause for the ruin of another group; synthetic products devaluated natural ones; establishment of ports, waterways, railroads disturbed existing equilibria. Inventions taking place on any one continent would start revolutions on some other, although the parties affected might not know it. Instead of making allowances for technological dislocations, nations insisted on maintaining traditional prerogatives, thus creating friction particularly distasteful to ruffled nerves kept on edge by the whip of technological competition, the perpetuated effort of keeping in step with the production parade. The leading nations became obsessed with the latent fear of getting outwitted in technological advance—everything contributed to accentuating tensions between industrial states. While the gravity and portent of potential conflicts increased, there was no powerful central idea as the one that had linked the Western World together before the advent of Reformation. Strangely, the ordinary people everywhere became most deeply imbued with group hatred and distrust, although it was precisely they who had to ultimately foot the bill. While engineers the world over consolidated their common tools and thought, their nations drifted apart. As to the additional comforts provided by technology, the contemporary French historian Seignobos says that happiness is a matter of individual feeling rather than of external appliances, and that our present setup is weakening our ability to enjoy the basic things in human life.

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[3] Engineer, Processes Research, Inc., Enquirer Bldg., Cincinnati, Ohio.

Dr. Münzinger presents his carefully documented facts, with the hope that ultimately those in charge of technological progress will be a body of men of refinement and culture, quick sensibility, broad intellectual horizon, and sufficient weight and standing to achieve a more equitable and more harmonious order than we have known during the first half of our century.

Library Services

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The New Men of Power, America's Labor Leaders

THE NEW MEN OF POWER, AMERICA'S LABOR LEADERS. By C. Wright Mills. Harcourt, Brace & Company, Inc., New York 17, N. Y., 1948. Cloth, $5^{1}/_{4} \times 8$ in., 323 pp., $3.50.

REVIEWED BY EDWARD H. HEMPEL[4]

FOR many years now, those in actual management have been asking: What is social science and what does it really aim to teach? And those who teach management have been waiting for a text which could be used to clarify the question: What should a manager do and how should he manage to "fulfill his social duties and responsibilities" and also his obligations toward mankind, as social science would see it.

So far no suitable text has come up, and this latest book is again only one of the kind which one may recommend to managers, students, and labor leaders for reading, but not for careful observation.

"The New Men of Power" is a book, the preparation of which has undoubtedly required great efforts. It is interestingly but sensationally written in the first and last pages. The main body of the study represents the findings of an inquiry poll held among 500 labor leaders for the purpose of analyzing them as a group, and to present their "power," their difficulties, activities, top-level organization, the differences between CIO and AFL, the liberal rhetoric, racketeer business, labor's image of business, programs and experiences, ties to political parties, and finally, their future potential for political power.

As far as the presentation is factual and objective it is good information; but whenever sensationalism gains the upper hand it weakens the book most thoroughly. To wit:

All managements, be they the "sophisticated conservatives, represented by magazines like *Fortune* and *Business Week*," or the very large group of the "practical right," which covers the middle-size and small businessmen who "during Democratic administrations display the psychology of the cornered animal" and "during Republican years and during wars or booms are gruff but ebullient"—they all are depicted as schemers, enemies of labor, and worse (pages 23–26, and many others).

The coming "slump" is mentioned over and over as possibly the most crucial period in American history. This may well be, but it is overlooked that a considerable readjustment from the present boom will have to be worked out by managements as well as by the new men of power, before there can be talk of any real slump. It is most doubtful that labor can solve the coming declines in demand by adoption of any "collective dream of the left manifest" (page 251), which is presented and advocates: workers' control over the social process of work (page 253); replacement of management function by workers' control at every point where its power permits (page 255); socialization of industry (page 258); continuous bookkeeping of the U. S. political economy (page 264); and a few similar measures.

Nor does it seem that any combination of labor leader power and labor intellect, as described in the book (pages 281 ff), with or without additional unionization of the white-collar and farmworker groups can bring about during the next "slump" or within one or two decades the social revolution which is claimed to be feasible in view of the occupational changes in the last two generations (pages 273–291).

As good as the study may be as a contribution to the social sciences—after most careful and fair appraisal it does seem that it is neither broad nor thorough enough to cover all those aspects adequately and properly which should be covered whenever labor, labor leaders, and, as is done in the study, also management and its kinds of leaders are dealt with. The subject is too vital for the entire economy to be treated in the peculiar style and attitude which have been applied.

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[4] Adjunct Professor, Industrial Engineering, Graduate Division, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Mem. ASME.

Power From the Wind

POWER FROM THE WIND. By Palmer C. Putnam. D. Van Nostrand Co., Inc., New York, N. Y., 1948. Cloth, 6 × 9 in., 224 pp., 113 figs., 23 tables, $6.

REVIEWED BY H. WEISBERG[5]

THIS book is primarily the story of the 1250-kw wind-power test unit installed on Grandpa's Knob, a mountain near Rutland, Vermont. The generator was first synchronized on the high line of the Central Vermont Public Service Corporation in October, 1941. Adjustments and tests continued under difficulties during the war years. In March, 1945, while on the line in commercial operation, a blade failure occurred due to a known weakness in design. A restudy of the economics of installing additional units of this type based on experience with the test unit indicated a cost of $205 per kw (1945 prices) as against a justifiable cost on the Vermont System of $125 per kw. While this gap might have been bridged by changes in design, funds for further experimentation were not made available and as a result the project has been abandoned.

In addition to the history of the installation the author has included a rather complete description of the design, fabrication, erection, and operation of the test unit as well as a comprehensive treatise on the behavior of the wind. A chapter on designs of other big windmills is particularly interesting. Also included is a proposed design for future units and possible ways to reduce costs.

The economics of wind power is discussed at length including itemized breakdowns of construction costs and evaluations of the worth. In general the figures appear to be reasonable. The author believes that large-scale wind power of 2000 or 3000-kw units, although limited to selected sites in windy regions near heavy load centers, nevertheless has a definite place in the power picture. He concludes that Government aid may be necessary to bring this about. Presumably conservation of natural fuel resources would be the justification. Whether or not one agrees, the book can be recommended as an authoritative text on the subject of wind power.

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[5] Mechanical Engineer, Electric Engineering Department, Public Service Electric and Gas Company, Newark, N. J. Mem. ASME.

Methods-Time Measurement

METHODS-TIME MEASUREMENT. By Harold B. Maynard, G. J. Stegemerten and John L. Schwab. McGraw-Hill Book Company, Inc., New York, N. Y., 1948. Cloth, 6 × 9 in., 292 pp., 113 figs., illus., $3.75.

REVIEWED BY F. M. GILBRETH[6]

METHODS-Time Measurement" is an expert synthesis of the latest developments in predicting operational times. The authors demonstrate that it is possible to predict accurately standard times for performing the seven selected basic movements—without a stop watch. Their data are based on the establishment of differentiations in degrees of manual difficulty and distances of movement.

Those working in element or therblig analysis will be interested especially in the contribution made toward combining job elements into common patterns.

This book is an excellent work. It is a fine text for industrial engineers and other technical men who develop methods; estimate the time required to perform a certain job; train supervisors in measurement procedures; and install incentive systems.

I found an opportunity to test their approach while patching a tar-paper roof this morning. First I assembled my equipment. Roofing nails are about one inch long, with a one-half inch head. Because of the head, it is a simple matter of touch to identify the position of the nail and to grasp it properly for driving. These motions would be more difficult if, for example, wire finishing nails were used.

To select the fastest Reach for my roofing job, I tested two of the five Reach classifications or cases described by the authors:

Case C: *Reach for Object in Group:* Even with easily separated roofing nails it is time consuming to pull out one nail and juggle it in your fingers until it is point down and at the same time move it into place for driving into the tar paper.

Case A: *Reach to an Object in Fixed Location:* When I laid my nails in a row alongside the place on the roof where they were to be driven, my work-reach cycle time was minimized and the roof repairing went on speedily. This simple test demonstrates that there are many degrees of complexity in even the most basic movements, be the action to reach, move, grasp, or turn. The authors do not intend that methods-time measurement can completely replace time-study techniques. They do point out, however, that the validity of their studies so far indicates that the correlation between a time-study standard and a methods-time measurement standard falls within an error limit of plus or minus five per cent. Though all-day time studies are still necessary to pick up personal time, effects of fatigue, dropped pieces, and broken tools, methods-time measurement will enable a trained person very quickly to set a standard which will be borne out in performance.

The authors stress, and properly so, that specialized training is vitally important before using this technique. As they point out, many operations or movements performed in an operation are at such speeds that it is very difficult for the human eye to trace them unless the human behind the eye has had sufficient familiarity with this technique to be able to reason what the elements of movement are. And in many cases, films must be taken of the operation so that the intricate movements can be seen even by fully trained analysts.

This book should not be taken as the compilation of formulas to set standards without a stopwatch, nor do the authors intend it to be. It is the result of several years of intensive experimentation and practice. The authors now feel that their findings are sufficiently valid to be made public. Since they intend to work further in this area, they welcome the contributions of others to the general fund of knowledge of the elemental times to perform certain standard movements.

It must be cautioned that this is not a book written for people with general interest in industrial engineering, but rather for technicians. Those individuals who have only general knowledge of time-study and methods work would do better to read other works by the authors and to engage in actual time-study and methods work before attempting to follow the recommendations presented. For those with a thorough understanding of time-study and methods work, however, this book can do much to broaden their knowledge and to increase their value to the organization for which they work.

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[6] Associate Engineer, McKinsey and Company, New York, N. Y. Mem. ASME.

Books Received in Library

Annual Report on the Progress of Rubber Technology, Vol. 11, 1947. Edited by T. J. Drakeley, published by W. Heffer & Sons Ltd., Cambridge, England, for the Institution of the Rubber Industry, London, S.W.1, England. Paper, $7^1/_4 \times 9^1/_2$ in., 145 pp., tables, paper, 12s 6d; 4s 6d to members of the Institution. The current issue of this technical literature survey covers the important aspects of the planting and production, chemistry and physics, and processing of raw rubber and other natural rubberlike materials. Separate chapters are also devoted to synthetic rubber, cellular rubber, hard rubber, and all of the major classes of rubber products. The selected bibliographies accompany their respective chapters as usual.

Atomic Energy. By Karl K. Darrow. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England. 1948. Cloth, $5^1/_2 \times 8^1/_2$ in., 80 pp., illus., diagrams, tables, $2. This small book contains four lectures given in the Norman Wait Harris lecture series at Northwestern University in 1947. The lectures include as much of the science of atomic energy as possible to give in four hours to an audience consisting largely of people whose special fields of interest were other than physics.

British Coal Utilisation Research Association, Information Circular No. 1. Description of a Fuel-Saving Device for Domestic Heating: The Stand-In Fire. By T. W. Grieve and J. S. Hales. The Association, London, S.W.1, England, 1948. Paper, $8^1/_4 \times 10^1/_2$ in. 6 pp., illus. A new type of combustion unit for ordinary fireplaces is described with test performance results. The object of the unit is to provide more efficient heating from less fuel than can be gained in the customary open grate.

Fracturing of Metals, a Seminar on the Fracturing of Metals held during the twenty-ninth National Metal Congress and Exposition, Chicago, Oct. 18 to 24, 1947. American Society for Metals, Cleveland, Ohio, 1948. Cloth, $6 \times 9^1/_4$ in., 311 pp., illus., diagrams, charts, tables, $5. Composed of papers dealing with an extremely complex problem, this volume does not claim to be a complete and correlated picture of the laws of fracture. Rather it deals with the specific phases which concerned members of the ASM seminar. Such varied topics as micromechanism of fracture, notched tensile testing, and theory of static fatigue for brittle solids are considered in the nineteen papers included.

Heat Engines. By S. H. Moorfield and H. H. Winstanley. Third edition. Edward Arnold & Co., London, England; Longmans, Green and Co., New York, N. Y., 1947. Stiff cardboard, $5 \times 7^1/_2$ in., 326 pp., illus., diagrams, charts, tables, $2.25. Containing fundamental principles, this book is intended for use as a text for a year course in heat engines. In this third edition, the Fahrenheit temperature system is used in all steam calculations and data. Other portions of the text have been rewritten and new examples included. A background of elementary physics is needed.

Induction Heating in Relation to Industrial Gas Heating. Project No. IGR-58. By S. L. Case and others; sponsored by American Gas Association, Committee on Industrial and Commercial Gas Research, New York, N. Y., 1948. Paper, $8^1/_2 \times 11$ in., 47 pp., illus., diagrams, charts, tables, $1. Appraising the past competitive position of gas and induction heating, this report also attempts to predict the future position. Divided into four sections, the first three outline the salient technological features of each type of heating and describe in some detail a few commercial examples of each type that have proved to be outstandingly successful. A fourth section presents an appraisal of metallurgical and economic factors which will be important in deciding which method is most suitable for future installations.

Introduction to Metallic Corrosion. By U. R. Evans. Edward Arnold & Co., London, England; Longmans, Green & Co., New York, N. Y., 1948. Cloth, $6 \times 9^1/_4$ in., 211 pp., diagrams, charts, tables, $3.25. Intended as an introductory text, this book is useful to both students and scientists. It is not a guide to practical preventive measures or a reference work, but rather a book suitable for continuous reading. It begins with an historical note which is followed by a basic chapter on electrochemistry. Only simple equations are used in all but the chapter on statistical methods. References to the literature are given at the end of the volume.

√ Mechanics and Applied Heat. By S. H. Moorfield and H. H. Winstanley. Longmans, Green & Co., New York, N. Y.; Edward Arnold & Co., London, England; Second edition. 1948. Cloth, $5 \times 7^1/_2$ in., 324 pp., diagrams, charts, tables, $1.60. Written as a one-volume course in engineering science, essential principles have been stressed throughout. Descriptive matter and detailed experimental instructions have been omitted in so far as possible. The revisions in this second edition are mainly in the chapter dealing with heat. New examples from recent British examinations have been added.

Metal Spraying and Sprayed Metal, rewritten by W. E. Ballard, Third edition, based on previous editions by E. C. Rollason, T. H. Turner, and N. F. Budgen. Charles Griffin & Company, Ltd., London, England; distributed in the United States by the American Metallizing Contractors Association, St. Louis, Mo., 1948. Cloth, $6^1/_4 \times 9$ in., 362 pp., illus., diagrams, charts, tables, 32s; $10 in U. S. A. This extensively revised edition is intended for the use of the operators of the process as well as the technician and scientist. New material has been added on the modern powder process, metal-spraying techniques, the preparation of surfaces, installation of plant and subsidiary apparatus, special processes, and on the properties of metal-sprayed surfaces. Descriptions of historical development and the comprehensive bibliography were omitted. However, references to relevant literature are listed at the end of each chapter.

√ National Conference on Industrial Hydraulics, Proceedings, 3rd Annual Meeting, Oct. 16–17, 1947. Armour Research Foundation, Chicago, Ill., 1948. Paper, 6×9 in., 129 pp., illus., diagrams, charts, tables, $3. The Conference attempts to fulfill a need for an interchange of ideas on problems confronted in the large field of industrial hydraulics. The papers from the third meeting deal with hydraulic-governor operation, hydraulic circuits of industrial process controls, various phases of cavitation, practical hydraulic-coupling design modifications, hydraulic transmissions, and the design of hydraulic seals.

Packaging Methods and Equipment. O. W. Roskill & Co. (Reports) Ltd., London, S.W.1, 1948. Stiff paper, $9^3/_4 \times 14$ in., 57 pp. plus Appendixes, 14 pp., 30s. Following an historical sketch, this mimeographed report describes the various types and methods developed for shipping containers, liquid packages, solid packages, finishing and handling equipment, and special forms of packaging. A list of British manufacturers of packaging materials and equipment is appended.

Résistance et Encombrement des Engrenages, 2 parts. By J. Bergère. Dunod, Paris, 1948. Paper, $8^1/_2 \times 10^3/_4$ in., 143 pp., figures, pp. 1–62, diagrams, charts, tables, 1250 fr. This detailed analytical treatment of the strength, loading, and interaction of various types of gearing provides useful design information. A separate section of some 60 pages of sketches, charts, and diagrams complements the text material.

Standard Methods for Testing Petroleum and Its Products. Ninth edition. Institute of Petroleum, London, W.1, England, 1948. Paper, $5^1/_2 \times 8^1/_2$ in., 616 pp., diagrams, charts, tables, 31s; also from American Society for Testing Materials, Philadelphia, Pa., $6.75. Over 100 test methods—adopted, tentative, or proposed—are described in this compilation which corresponds to the similar ASTM publication in this country. The test methods cover a wide range: acidity, carbon residue, distillation processes, cloud and pour points, knock ratings, viscosity, and special tests such as for the determination of zinc in lubricating oil.

Theory and Practice of Heat Engines. By R. H. Grundy. Longmans, Green and Co., London, England; New York, N. Y., Toronto, Canada, 1947. Cloth, $5^1/_2 \times 8^3/_4$ in., 723 pp., illus., diagrams, charts, tables, $6. The theory section of this introductory text is developed from the basic principles and emphasizes its dependence on physics and chemistry. The practical section covers boilers, steam engines, steam turbines, and internal-combustion engines. Descriptions of the latest plant are included.

Thermodynamics. By E. F. Obert. McGraw-Hill Book Co., Inc., New York, N. Y., Toronto, Canada, London, England, 1948. Cloth, $6 \times 9^1/_4$ in., 571 pp., illus., diagrams, charts, tables, $5.50. Intended for use by engineering students, this fundamental text presents a comprehensive treatment of the subject. It provides certain essential material that must be understood by the practicing engineer, and considerable stress is placed upon real machines, flow processes, and the properties of fluids. An entire chapter is devoted to the concept of reversibility and another deals with dimensions and units.

Year Book of the Heating and Ventilating Industry, 1948. Technitrade Journals, Ltd., London, W.C.1, England. Cloth, $5^1/_2 \times 8^3/_4$ in., 206 pp., illus., 5s. Of interest to architects, consulting engineers, and those who deal with heating and ventilating contractors, this compact volume contains technical, contractual, and trade information. In addition to articles on various phases of the field, there are a buyers' guide, a list of technical and trade associations, and a list of trade names. The officers and members of the Association of Heating, Ventilating, and Domestic Engineering Employers are also included.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of September 17, 1948, and approved by the Council on October 25, 1948.

CASE No. 896 (Reopened)*

(*Special Ruling*)

Inquiry: Is it permissible under the rules of Section VIII of the Code, to construct fusion-welded pressure vessels of clad material complying with Specifications SA-263, SA-264, and SA-265?

CASE No. 1064*

(*Special Ruling*)

Inquiry: May heating boilers built under the rules of the Low-Pressure Heating Boiler Code be constructed from copper or copper base alloys? If so, what minimum material thicknesses may be used and what special requirements would apply?

CASE No. 1069 (Reopened)

Add the following:

In Table Q-5, Grade WC5 will be included under "P" Number 4—"O" Number 1, and Grade WC9 will be included under "P" Number 5—"O" Number 1.

CASE No. 1076

(*Interpretation of Par. U-13**h***)

Inquiry: Is it permissible, under Par. U-13(**h**) of the Code, to use Classes 50 and 60 cast iron complying with ASTM Specifications A 48-46 in the construction of unfired pressure vessels?

Reply: It is the opinion of the Committee that Classes 50 and 60 cast iron complying with ASTM Specifications A 48-46 may be used under Par. U-13(**h**) of the Code provided such castings are marked with the Class number and the producers name or identification symbol. The following working stresses may be used:

Class	Max Tension	Max Bending	Max Compression
50	5000	7500	10,000
60	6000	9000	12,000

Castings and test bars shall be stress-relieved by placing them in a suitable furnace at a temperature not exceeding 400 F. The heat-treating charge shall be uniformly heated to a temperature of not less than 900 F nor more than 1050 F. Castings shall be held above 900 F for not less than 1 hr nor more than 2 hr per inch of thickness of the thickest section. The heating and cooling rates shall be uniform and shall not be more than 400 F per hr for castings of 1 in. maximum section, nor more than 400 F divided by the maximum thickness in inches for thicker castings.

CASE No. 1078*

(*Special Ruling*)

Inquiry: Is it permissible, under the rules of the Code, to construct fusion-welded pressure vessels that are lined with corrosion-resistant materials welded either to the plates before forming or to the shell, heads, and other parts after assembling and welding of the base metal parts? The contemplated methods of attaching the lining material may not produce composite material meeting the continuous bonding requirement for clad materials covered by Case No. 896.

CASE No. 1079

(*Interpretation of Fig. H-3*)

Inquiry: How should the requirements of Fig. H-3 of the Code be determined for boilers which do not have a normal grate line?

Reply: It is the opinion of the Committee that for the recommended return pipe loop connection shown in Fig. H-3 use $1^{1}/_{2}$ in. pipe size for boilers with minimum safety valve relieving capacity 250 lb per hour or less, use $2^{1}/_{2}$ in. pipe size for boilers wth minimum safety valve relieving capacity from 251 lb per hour to 2000 lb per hour, inclusive, use 4 in. pipe size for boilers with minimum safety valve relieving over 2000 lb per hour.

CASE No. 1080

(*Interpretation of Table Q-5*)

Inquiry: May the steel plate covered by Specification SA-299 be included in Table Q-5 of the Code, and if so, under what "P" and "O" numbers?

Reply: It is the opinion of the Committee that the material covered by Specification SA-299 is perfectly weldable when properly preheated and this material fits into Table Q-5 under group "P" Number 4—"O" Number 1 except that the carbon content of this steel is greater than 0.28 per cent in its heavier thicknesses. It has therefore been decided to eliminate the carbon restriction from the heading of this group and to introduce a note on preheating as follows: "Experience has indicated that it is advisable to preheat to at least 350 F when welding the materials included in this group."

CASE No. 1081

(*Interpretation of Table U-3*)

Inquiry: Par. UA-19(**a**) of the Code refers to working stresses for bolting material in Table U-3. What allowable working stresses are permitted for copper-silicon alloy bolting material conforming to Specification SB-98?

Reply: It is the opinion of the Committee that pending a revision of Table U-3, the following allowable working stresses for copper-silicon bolting material conforming to Specifications SB-98 may be used:

Spec no.	Grade, type, or name	Notes	Spec min tensile	Subzero to 150 F	250 F	300 F	350 F
SB-98	A, C, D-soft	(3), (5)	52,000	3000	3000	3000	3000
SB-98	A, C, D-$^{1}/_{2}$ hard	(3)	70,000	7600	7600	7600	7600
SB-98	B-soft	(3)	40,000	2400	2400	2400	2400
SB-98	B-$^{1}/_{2}$ hard	(3)	55,000	4000	4000	4000	4000

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* The replies to Cases Nos. 896, 1064, and 1078 are lengthy ones and may be obtained by writing to ASME headquarters, 29 West 39th St., New York 18, N. Y.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Sharing the Load

IF professional engineering societies are to continue to measure up to the needs of the profession, and indirectly the public, they need the support of competent engineers.

In his presidential address before the Illuminating Engineering Society, R. W. Staud of the Benjamin Electric Company, outlined the three fundamental purposes of engineering societies as: (1) Accumulation of engineering knowledge; (2) interpretation of this knowledge by technical committees into recommended practices and methods of procedure, and (3) dissemination of knowledge and recommended practices and methods.

These purposes provide an insight into the relationship of the engineer to his society. If the engineer remains aloof, American engineering suffers in two ways.

First, as a successful practitioner, the engineer makes use of publications, standards, handbooks, and other information accumulated and made available through the time and money of his fellow engineers. The sum of these professional aids is limited by the funds available for their creation. If the engineer does not support these activities by paying dues to some engineering organization he is jeopardizing the sources upon which his proficiency depends. Without funds, meetings cannot be organized, important papers cannot be published, standards cannot be revised, and new accumulations of data in the form of new handbooks cannot be created.

Secondly, if his work is in new fields where success depends on extrapolation of existing knowledge, the American engineer will lose if he does not make his experiences and ideas available to the profession. Keenly aware that new ideas are the life of any professional group, the engineering societies spend their funds to maintain a forum for the cross-fertilization of ideas. It is natural for the engineer outside the fraternity of engineers to miss the opportunity of subjecting his ideas to the constructive criticism. An idea which does not find a place in the record of engineering progress tends to dry up at its source without serving as an influence in the revision of existing practices and methods. We all lose when American recreative thinkers are content to wait upon engineers overseas to provide the leaven for American engineering.

Engineering societies are notoriously poor because the job to be done is so vast. Available funds are immediately earmarked for publications, research, and services. Fortunately, dues is not the only source of income, but provides the basic funds for operations. What income is available through sale of publications is diverted to society services and this makes it possible for engineering societies to return to the profession services well in excess of the value of dues received.

Engineers are urged to take a moment to consider their relationship with the engineering societies in their particular field and to decide whether they are contributing in fair measure to the work of the engineering profession.

Registration

SINCE passage of the engineering registration law in New York, 12 examinations for professional-engineer licenses have been held and 10 examinations for certificates as engineer-in-training. A cumulative statistical analysis of the results of these examinations shows, according to an article by D. B. Steinman in the September issue of *The Registration Bulletin*, that professional-engineer candidates who graduate from accredited schools have a 7 to 5 advantage over candidates from nonaccredited schools or those with partial college credits.

Dr. Steinman states that of the 2630 candidates for registration, 2231 or 85 per cent were graduates of accredited colleges and, of these, 70 per cent passed; 260 candidates or 10 per cent were either from nonaccredited schools or had partial college credit, and of these 47 per cent passed; 139 or five per cent had only high-school credit and of these 22 per cent passed.

The results show that the academic curricular background of the candidates seems to have little effect on the success of candidates. Chemical engineers had the best record with 72 per cent of the candidates passing but they showed only a 3 per cent advantage over the civil engineers, 69 per cent of whom passed the examinations. Mechanical engineers rated second with 71 per cent; and electrical engineers third with 70 per cent.

The examinations were most popular with civil engineers, 907 of whom took the examinations since 1942; mechanicals were next with 660, electricals next with 457; and chemicals last with 207.

Among the 1112 young graduate engineers who took the engineer-in-training examinations, mechanical engineers stood first with 79 per cent passed. Civils came next with 74 per cent; chemicals with 72 per cent; aeronauticals 71 per cent, and electricals 69 per cent. Of the graduates of accredited schools, 75 per cent passed as compared to 43 per cent from nonaccredited schools.

Increasing interest in the engineer-in-training examinations was evident during the July examinations when more candidates enrolled for the engineer-in-training than the professional-engineer examinations. The total enrollment was 1208, a new record.

Objectivity

UNLESS engineering students learn to discover and deal with the human and social aspects of their professional problems under the favorable conditions of college instruction, they will be ill-equipped to deal with them or even discover them amid the hurried and confusing conditions of professional practice, according to Prof. Elliott Dunlap Smith, whose article, "The Education of Professional Students for Citizenship" appears on pages 959–962 of this issue. Experience shows, he says, that "so long as general and professional education are taught apart from one another, merely because a student has learned to think analytically, thoroughly, and unemotionally in dealing with technical problems gives no assurance that he will do so in dealing with human and social problems."

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THE TECHNICAL program for the third Materials Handling Conference prepared by the Management and Materials Handling Divisions of The American Society of Mechanical Engineers, has for its theme: Cost reduction through use of modern materials-handling techniques. For tentative program see pages 1036.

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FOR REPORTS of the Wood Industries Conference and the Petroleum Mechanical Engineering Conference both sponsored by The American Society of Mechanical Engineers, see pages 1037–1038.

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ACCORDING to A. G. Bryant, president of the National Machine Tool Builders' Association, capacity of the American machine-tool industry has slumped so far from its wartime peak that about six months would be required to regain the rate of production that will be required in event of war. The European Recovery Program has had little beneficial effect so far because foreign countries have been encouraged to cancel their orders for machine tools and use funds for other purposes.

* * *

UNDER a new policy adopted by the Department of the Army, it is now possible for engineers with no previous military training to receive appointments in the Officers' Reserve Corps with the rank of second lieutenant up to colonel, depending on age, experience, and education. Mechanical engineers in the automotive industry are especially sought by the Reserve Corps.

Economy

SINCE government as well as households, over a reasonable period of time must live within their incomes, Wilson Compton in his article (pages 963–966 of this issue) advocates the following steps to insure a sound national economic structure: (1) a forthright plan for orderly payment of the national debt; and (2) a national system of income taxation which will enable Government to pay its debts without retarding industrial enterprise. "If Congress tries to make us too comfortable, it will only be making our grandchildren too uncomfortable; and if Congress makes us too uncomfortable, there may be no grandchildren," he states.

* * *

A COMMITTEE on Plans for Mobilizing Science is studying the problem of organization of scientific resources in event of a national emergency, according to Vannevar Bush, until recently, chairman of the Research and Development Board. The new committee headed by Irvin Stewart, president, West Virginia University, Morgantown, W. Va., is to make recommendations on the role the Research and Development Board would play under wartime conditions, and to suggest plans for the integration of present organization with any new organizations which may seem desirable in time of war.

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WITH the completion of a new headquarters building in Detroit, Mich., the American Society of Tool Engineers has achieved its major goal of the past three years. The new building provides 12,000 sq ft of floor space on one floor of a modernistic building. Funds for the project were obtained from an issue of $4^1/_2$ per cent investment bonds, totaling $110,000, which were sold only to ASTE chapters and members.

Library

ENGINEERS who have foundered in a technical library searching for engineering information will welcome the article, "Use of a Technical Library" (pages 987–993) by R. H. Whitford and J. B. O'Farrell. The article is a guide to suitable procedures for locating data in the various forms of technical literature. The authors describe each type from the standpoint of subject content and how this content can be reached through skillful use of bibliographical tools.

Management Skills

THE MOST elusive skills in management are those prerequisite to the selection of the appropriate standards for comparison at a given time, and to the detection of the need for changes in standards, as well as to the reconciliation of those that are in apparent conflict with the constantly changing standards of products and services demanded by customers, creditors, competitors, labor, government, stockholders, and the general public, Robert W. Elsasser states in his current article, "Tools and Techniques of Management" (pages 979–980).

THREE new aircraft engines, a turbocyclone compound engine, a piston-jet engine and a turboprop engine, developed for military and commercial aircraft were announced recently by the American aircraft industry. For descriptions see page 1002.

A NEW factor in safe operation of transport and military aircraft was introduced recently when a fire-resistant hydraulic fluid developed jointly by the Douglas Aircraft and Monsanto Chemical Companies was announced in New York, N. Y. See page 1007.

LAST October the Standard Oil Development Company held open house at its new Esso Research Center, Linden, N. J. An account of the ceremonies appears on page 1000.

Expositions

THE Sixth Western Metal Congress and Western Metal Exposition will be held in the Shrine Auditorium, Los Angeles, Calif., April 11–15, 1949.

A technical program is being developed by the ASM in co-operation with the western sections of 20 other national technical societies. Leading engineers from both the metals producing and consuming industries will participate in making the Western Metal Congress a timely source of vital information on all phases of metal science. Manufacturers of basic materials as well as processors of all types of industrial products will display the latest developments and techniques of their business in what is promised to be the most comprehensive and impressive exposition yet held on the West Coast.

* * *

THE ninth International Heating and Ventilating Exposition will be held at the International Amphitheatre in Chicago, Ill., Jan. 24–28, 1949. The exposition is sponsored by the American Society of Heating and Ventilating Engineers in conjunction with its 55th annual meeting. It marks the third year of increasing interest on the part of those concerned with the heating, ventilating, and air conditioning of industrial, commercial, and domestic establishments. The last two expositions were held in Cleveland and New York, respectively.

THE third Materials Handling Exposition and Conference will be held at Convention Hall, Philadelphia, Pa., Jan. 10–14, 1949. For story see page 1036.

Nuclear Energy

ANNOUNCEMENT by the American Institute of Architects of the creation of a Committee on Atomic Age Architecture has added another team to the number of engineering and scientific groups now working on the unsolved problems introduced by nuclear energy.

In their studies of designs of buildings to protect workers and inhabitants from radiation, the proper geographical dispersal of industrial buildings devoted to nuclear-energy research and production of nuclear power, and in their attack on the major unsolved problem—the disposal of nuclear wastes—American architects will have the encouragement and aid of the engineering profession.

Since 1946 The American Society of Mechanical Engineers has had a committee studying the beneficent application of nuclear energy. This committee has directed its attention to five specific fields: (1) Safety codes covering biological, chemical, and physical hazards; (2) standardization of nuclear-energy definitions, constants, units, and symbols; (3) standard specifications for materials of construction; (4) test procedure for materials; and (5) power test codes for nuclear-energy generators and processing systems. During 1948 substantial progress has been made on a glossary of nuclear-energy terms, of which Section VI on Biophysics has been completed.

Definitions

THE following definitions for mechanical engineering and the professional engineer were recently adopted by the California Board of Registration for Civil and Professional Engineers under provisions of the Professional Engineers' Act which was passed by the California State Legislature in 1947:

"'Mechanical Engineering' is that branch of professional engineering which embraces studies or activities relating to the generation, transmission, and utilization of thermal and mechanical energy, and the production of tools, machinery, and their products. It is concerned with the research, design, production, operational, organizational, and economic aspects of the above.

"'Professional engineer,' within the meaning and intent of this act, shall mean a person engaged in professional practice of rendering service or creative work requiring education, training and experience in engineering sciences, and the application of special knowledge of the mathematical, physical, and engineering sciences in such professional or creative work as consultation, investigation, evaluation, planning or design of public or private utilities, structures, machines, processes, circuits, buildings, equipment or projects, and supervision of construction for the purpose of securing compliance with specifications and design for any such works."

AAAS Appoints Editorial Board

THE American Association for the Advancement of Science has appointed an editorial board of five distinguished scientists who will serve with a Yale University biologist to direct the activities of the two publications of the organization—*Science* and *The Scientific Monthly*.

Chairman of the editorial board and editor in chief of both publications will be George A. Baitsell, Colgate Professor of Biology at Yale University, New Haven, Conn.

Others on the board representing various scientific fields are: Arthur C. Bevan, Illinois State Geological Survey; Edward U. Condon, director of the National Bureau of Standards; Bentley Glass, The Johns Hopkins University; Malcolm H. Soule, University of Michigan; and Everett S. Wallis, Princeton University.

Pattern of International Co-Operation Agreed Upon by Western European and American Engineering Societies

HOW engineering societies can better serve the engineering profession of western Europe and the United States was the topic discussed at an international conference held in London, England, Oct. 4–8, 1948, at the invitation of The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers.

Participating Societies

The following societies were represented: Belgium, Société Royale Belge des Ingénieurs et des Industriels; Denmark, Dansk Ingeniørforeningen; France, Société des Ingénieurs Civils de France; Holland, Koninklijk Instituut van Ingenieurs; Norway, Den Norske Ingeniorforening; Sweden, Svenska Teknologforeningen; Switzerland, Schweizerischer Ingenieur und Architekten-Verein; United States, Engineers Joint Council, composed of American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers; The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Institute of Chemical Engineers; and Great Britain, The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers.

The following conclusions were agreed upon as a result of the discussions:

Future Conferences

The Conference is of the opinion that it is desirable to foster international co-operation between professional engineers through contacts between the recognized national engineering societies of each country. The Conference therefore recommends:

(*a*) That the present Conference stands adjourned for a period of one year, or to an earlier date according to the need; and that in the interval the principles of collaboration be developed between the Participating Societies through the Secretariat of the present Conference.

(*b*) That further conferences of similar character be held in order to foster to the utmost the international collaboration which is envisaged.

International Co-Operation

The Conference also submits the following recommendations for the consideration of the governing bodies of the Participating Societies:

1 That where advance information on forthcoming papers of a Participating Society can be made available, this be circulated as soon as possible to the other Participating Societies, to enable note to be taken of papers of special interest.

2 That arrangements for the invitation of visiting lecturers by one Society from another may, as desired, be put in hand by communication between the Secretariats of the Participating Societies concerned.

3 That arrangements between the Participating Societies on a reciprocal basis for the extension of limited privileges of membership to visiting members from other Participating Societies are desirable, such arrangements being based on bilateral agreements between the Participating Societies and conforming as far as possible to the following pattern:

(*a*) The visiting members of all grades to be accredited by a letter sent from the Secretary of one Society to the Secretary of the other as well as by a similar letter carried by the visiting member.

(*b*) The normal duration of the arrangements for any one visiting member to be six months.

4 That the formation by one Participating Society of a Branch in territory of another is undesirable except by mutual agreement, and that each Participating Society should urge its members to join the National Society in the country in which they live. It is recognized as natural and proper that members of one of the Participating Societies residing in a foreign country may properly set up in that country branches or sections for social and technical meetings.

5 That to assist with existing Abstract Services and their co-ordination and extension, each Participating Society agrees

(*a*) to send details of the abstracting services operating in its territory to the Conference Secretariat, with a note of the periodical publications they cover;

(*b*) to consider the utility of the Universal Decimal Classification System (Brussels extension of the Dewey System) and to foster its use in so far as practicable;

(*c*) that brief informative summaries in English should precede or follow papers in other languages published by the Participating Societies, particularly where the language concerned is not widely spoken.

6 That each Participating Society should be prepared to supply the names and coverage of the principal technical and scientific journals published within its territory to other Participating Societies.

World Engineering Conference

To achieve the objects which it seeks to attain, the Conference considered the possibility of using the CTM (Conference Technique Mondiale; World Engineering Conference) but the Conference was of the opinion that the CTM under its present Constitution is not the appropriate organization for this purpose.

The American representation consisted of Ernest E. Howard, Fellow ASME, past-vice-president of American Society of Civil Engineers; Col. W. N. Carey, secretary, American Society of Civil Engineers; and C. E. Davies, secretary, The American Society of Mechanical Engineers.

Mechanical Transmissions Safety Code Revision Planned

AS administrative sponsor of ASA Sectional Committee on Safety Code for Mechanical Transmission Apparatus, B15, The American Society of Mechanical Engineers recently took the first steps in a revision of the 1928 code by naming D. C. Wright, Mem. ASME, vice-president, Wallace, Wright, and Van Fossen, Inc., as chairman to reactivate the committee.

While the present code is basically sound, comments have been received indicating that it does not adequately cover V-belt transmissions, hundreds of thousands of which have been installed in industry during the past two decades. Revision is also desirable in order to include in the code the newer techniques and materials introduced in the field of transmission guarding.

A meeting of the reactivated committee is expected to be called early in January, 1949.

Vannevar Bush Resigns NME Research Post

THE resignation of Vannevar Bush, chairman of the Research and Development Board of the National Military Establishment, and the appointment to succeed him of Karl T. Compton, president of the Massachusetts Institute of Technology, was recently announced.

Dr. Bush and Dr. Compton served the Government in major scientific roles throughout the war years. They were close collaborators from 1943 to 1945 when Dr. Compton was chief of field service of the Office of Scientific Research and Development, predecessor of the present board. Dr. Bush was the director of the Office of Scientific Research and Development from its establishment in 1940.

Dr. Bush will devote himself principally to the presidency of the Carnegie Institution of Washington, an office he has held since 1939. His resignation from the Federal post became effective Oct. 14, 1948.

One of Dr. Compton's most recent major labors for the Government was as chairman of the President's Advisory Commission on Universal Training. Among the offices he holds is the chairmanship of the Joint Chiefs of Staff Evaluation Board on Atomic Bomb Tests. Recently President Truman appointed him a member of the United States Advisory Commission on Educational Exchange, which will formulate policy on exchange of students with foreign countries.

Dr. Compton became president of the Massachusetts Institute of Technology in 1930. He resigned this post at the annual meeting in October and was elected chairman of the Institute corporation.

On his recommendation James R. Killian, Jr., was chosen to be the tenth president of MIT. Dr. Killian, who is 44 years old, has been vice-president since 1945. He is the first alumnus to head MIT having been graduated in 1926. He began his administration

October 15 and will be formally inaugurated in June, 1949.

Engineering Foundation Announces New Officers and Projects

The Engineering Foundation elected Joel D. Justin, consulting engineer of Philadelphia, Pa., as its chairman at the annual meeting of its board held recently in the Engineering Societies Building, New York, N. Y. Boris A. Bakhmeteff, Mem. ASME, consulting engineer and professor of civil engineering, Columbia University, was chosen vice-chairman. Re-elected officers included Edwin H. Colpitts, formerly vice-president of the Bell Telephone Laboratories, as director, and John H. R. Arms, Mem. ASME, as secretary.

Mr. Justin was also appointed chairman of the executive committee. Others to continue their terms on the executive committee are: Mr. Arms as secretary; also O. E. Buckley (AIEE), president, Bell Telephone Laboratories; A. B. Kinzel, vice-president, Union Carbide and Carbon Research Laboratories, Inc.; and R. H. Chambers (ASCE), former vice-president and consulting engineer of the Foundation Company. Herman Weisberg, Mem. ASME, electrical-engineering department, Public Service Company of New Jersey, was also appointed to the Committee.

The Research Procedure Committee will be headed by Dr. Bakhmeteff. Other members are: E. R. Kaiser (AIME), assistant director of research, Bituminous Coal Research, Inc.; William A. Newman (ASME), chief of research, Canadian Pacific Railway; and C. D. Suits (AIEE), assistant to the director of the research laboratory, General Electric Company, Schenectady, N. Y.

Reports were made at the meeting on 18 research projects aided by The Engineering Foundation during the past year. The projects were concerned with studies in such varied fields as hydraulics, alloys of iron, properties of gases and gas mixtures, riveted and bolted structural joints, welding, and properties of metals at different temperatures.

Grants were recommended for the year 1948–1949 for the continuation of nine of the 18 projects of the past year and for the support of five new projects among which are: Council on Research in Reinforced Concrete; Mechanical Properties of Binary Alloyed Ferrites at Low Temperatures; and Unsteady Heat Flow Film Conductance.

The Engineering Foundation has now been engaged in important research activities for more than 31 years. It aided in establishing the National Research Council and its division of Engineering and Industrial Research. It has contributed to the support of the Engineers' Council for Professional Development which, representing some eight engineering organizations, aims at the advancement of the engineering profession. The Foundation has supported engineering research and investigations in many varied fields.

American Progress in Standardization Discussed at ASA 1948 Annual Meeting; New Officers Announced

The legality of standardization, the program of the Munitions Board in bringing about co-ordinated standards for the Military Establishment, the organization of company standards work, and methods of evaluating standards were some of the subjects taken up in lively discussions of the question "What Good Are Standards?" at the 30th annual meeting of the American Standards Association, Oct. 20–22, 1948, in New York, N. Y.

The Honorable W. John Kenney, Under-Secretary of the Navy, speaking on the importance of simplification and standardization to an efficient and economical military supply system and thus to our national security, was the featured speaker at the luncheon which closed the three-day meeting. Mr. Kenney described the steps being taken by the Munitions Board to bring about co-ordination of the standards of the Army, Navy, and Air Force, and to unify them with industry's specifications.

John F. Sonnett, partner in the firm of Cahill, Gordon, Zachry, and Reindel, and former assistant U. S. attorney general, discussed the legal aspects of standardization at the special session for company members of the Association on October 20. Earl O. Shreve, Mem. ASME, president, Chamber of Commerce of the United States, served as moderator for a panel discussion and made the keynote address at the session of the association and technical society members on October 21.

New Officers Announced

New officers for the coming year were announced at the meeting. Thomas D. Jolly, vice-president in charge of engineering and purchases of the Aluminum Company of America, will be president. Harold S. Osborne, chief engineer of the American Telephone and Telegraph Company, and past-chairman of the Standards Council of the Association, will be vice-president. Dr. Osborne is now serving as vice-president of the United States National Committee of the International Electrotechnical Commission, and is past-president of the American Institute of Electrical Engineers, the American Society of Planning Officials, and director and vice-president of the Regional Planning Association.

Announcement of election of officers of the Standards Council, the technical governing body of the Association, was also made at the meeting. L. F. Adams, consultant of the General Electric Company, who died suddenly Oct. 14, 1948, had been elected chairman by letter ballot and W. C. Wagner of the executive department, Philadelphia Electric Company, vice-chairman. Because of the death of Mr. Adams, Mr. Wagner was named acting chairman.

Also re-elected for the coming year were Vice-Admiral G. F. Hussey, Jr. (USN, ret.), secretary ASA; and Cyril Ainsworth, technical director and assistant secretary.

Armed Forces Co-Ordinate Standards

The final luncheon session heard W. John Kenney, Under-Secretary of the Navy, explain that two steps have been taken toward co-ordination of the standards for all the equipment used by the Military Establishment. These are establishment by the Munitions Board of its Cataloging Agency and its Standardization Agency. The catalog system is intended to provide a single name, description, and identification number for each item used, thus eliminating about 50 per cent of the 5 million items involved, he explained. The operations of the Standards Agency will include development of common designs of equipment and components. When they are fully under way it is planned that Army, Navy, and Air Force Specifications will no longer be published by the respective departments. The co-ordinated specifications will be National Military Establishment (NME) specifications.

"To achieve the closest possible tie between industrial and military standards it is hoped that NME specifications, which may have aspects in common with industrial standards, will be sent through the procedure of the ASA to become American Standards," Mr. Denney said. "This should assure a common material language for both industry and the Services."

The Standards Agency also promulgates NME Engineering Standards, which are put out for reference purposes in drawing up specifications. Their use by the Military Establishment is mandatory and industry is encouraged to follow them in commercial drawings whenever possible.

Legal Aspects

The first day's meeting was for the company members of the Association. Mr. Sonnett, speaking on the "Legal Aspects of Standardization," told the company representatives that standardization is an economic necessity in a mass-production system such as ours, and it becomes unlawful only when it is used as a device for the suppression of competition. He referred to the Supreme Court decisions affecting industry-wide pricing systems in the Sugar Institute case and the Cement Institute case. Pending Congressional clarification of problems raised by these decisions, producers of standardized products should make "independent competitive determination" of their prices, he said. "The price charged by a businessman should be his own price whether or not his product is standardized, and whether or not his price is the same as his competitors," he declared.

A panel discussion on the value of standards in engineering, purchasing, and production was the feature of the afternoon session. Willis S. MacLeod, deputy director of the Standards Branch, Bureau of Federal Supply, U. S. Treasury Department, was moderator and pointed out the difficulty of establishing a monetary value for standardization. Standardization was described as a co-operative function of the engineering, production, purchasing, and sales departments because of its important role and broad scope. It should be under the direction of an officer of a company, in the opinion of W. P. Kliment, engineer of standards, Crane Company. He analyzed the objectives of standardization as including: to obtain the maximum interchangeability, simplification of parts and practices, economy of manufacture, improvement of quality with possible savings to the consumer, and consistency of appearance; to avoid duplication of effort; to co-operate in the development of industry standards; to promote uniformity of procedure.

Value of Standards

Executives of the association and technical society members of the American Standards Association heard a panel discussion on the question "What Good Are Standards?" on the second day of the meeting. Mr. Shreve, as keynote speaker, called on industry to furnish the leadership to keep standardization a voluntary co-operative movement and warned against the possibilities that the government might assume proprietary interests in standardization or that standards might become controls which would place restrictive mandatory procedures on industry. He pointed to the "record-breaking year" for peacetime production and all-time employment and gave standardization credit as one of the basic factors behind today's statistics. "As a voluntary co-operative movement, sparked by enlightened leadership, standards represent 'know how'—the kind of 'know how' that has made American industry the productive giant upon which the world, in great part, has come to depend," Mr. Shreve said.

Following Mr. Shreve's keynote speech, a panel of executives of different industries and one representative of the consumer viewpoint gave their views on the value of standards in purchasing, manufacturing, and marketing to wholesalers and retailers and to the consumer.

Edward C. Meagher Elected President UET

EDWARD C. MEAGHER, treasurer, Texas Gulf Sulphur Company, New York, N. Y., Mem. AIME, was elected president of the United Engineering Trustees, Inc., at its annual meeting in the Engineering Societies Building, New York, N. Y., Oct. 28, 1948.

Other officers elected were: James F. Fairman (AIEE), vice-president, Consolidated Edison Company of New York, as vice-president; Irving Huie (ASCE), president of the Board of Water Supply, New York, as vice-president; Kurt W. Jappe (ASME), treasurer, ASME, (re-elected) as treasurer; James L. Head (AIME), department of mines, Chile Exploration Company, New York, (re-elected) as assistant treasurer. John H. Arms (AIME, ASME) was re-elected secretary.

Col. William N. Carey, secretary of the American Society of Civil Engineers, will head the Real Estate Committee, which includes Mr. Head, Mr. Seely, and Mr. Fairman.

Engineering Awards

THE American Institute of Mining and Metallurgical Engineers recently announced the recipients of the following AIME awards for 1949:

W. L. Saunders Medal for distinguished achievement in mining, to Stanley Alexander Easton, president, Bunker Hill and Sullivan Mining and Concentration Company. Mr. Easton has been instrumental in the development of his company into one of the largest lead and silver mining companies in the world.

James Douglas Gold Medal for distinguished achievement in nonferrous metallurgy, to William Wraith. The award recognized Mr. Wraith's work as a metallurgist in the beneficiation of nonferrous ores and as an able administrator in the field of copper production.

Charles P. Rand Medal for distinguished achievement in mining administration (posthumously), to the late Harry Carothers Wiess, until his death, president of the Humble Oil and Refining Company of Houston, Tex., a company which he helped to organize. Mr. Wiess had a distinguished record of industrial and public service.

PRIZE awards for the best papers on resistance-welding topics submitted in the 1947–1948 national contest were announced recently by the American Welding Society. All prizes were donated by the Resistance Welder Manufacturers' Association.

First prize winner in the industrial division of the contest was Frank G. Harkins, Solar Aircraft Company, San Diego, Calif., who was presented with $750 for his paper on "Spot Welding for Nickel Schedules and Nickel Alloys." In the university-source division first prize went to W. F. Hess, W. D. Doty, and W. J. Childs, all of Rensselaer Polytechnic Institute, Troy, N. Y., for their paper "Heat-Treatment of Spot Welds in Steel Plate."

The second prize of $500 in the industrial division went to R. C. Jones, Taylor Winfield Corporation, Warren, Ohio, for his paper on "Resistance Welding of Crossed Wires," while C. E. Smith and R. H. Blair of the same company collaborated to win the $250 third prize with their paper on "Resistance Welding Characteristics of the Dry Disk Rectifier Welder." W. F. Hess and W. J. Childs of Rensselaer also were awarded second prize in the university division for their paper on "A Study of Projection Welding."

VANNEVAR BUSH, until recently, chairman of the Research and Development Board of the National Military Establishment, has been awarded the 1949 medal of the Industrial Research Institute, Inc. The citation accompanying the award, which will be presented at the February, 1949, meeting of the Institute, reads: "Dr. Vannevar Bush for his leadership in the Office of Scientific Research and Development, in marshaling industrial and academic research and co-ordinating it with the military effort in the common defense, developing an instrument of government so effective as to provide a pattern for continued service."

RALPH BROWN, director of research, Bell Telephone Laboratories, has been awarded the Medal of Honor of the Institute of Radio Engineers in recognition of his contributions to radio communications.

THE first award of Columbia University's Kemp Medal was made to Charles P. Berkey, Newberry professor emeritus of geology, Columbia University, for distinguished achievement in geology. Dr. Berkey is an authority on New York's bridges, tunnels, and foundations.

People

KNIGHTHOOD was recently conferred on Air Commodore Frank Whittle, inventor of the turbojet engine. In addition, the British government awarded him a sum of £100,000 tax-free for wartime use of his patents, and the services of his company, which he gave to the nation without charge. ASME members will recall that as the 1946 Guggenheim Medalist, Sir Frank described the development of his engine at a luncheon meeting of the 1946 ASME Annual Meeting in New York, N. Y.

THE American Welding Society has elected George N. Sieger, president, S-M-S Corporation, Detroit, Mich., as its president for the year 1948–1949. He is a graduate of Lehigh University with a degree of electrometallurgist.

GENERAL Lucius D. Clay, commander-in-chief of American Forces in Europe, and military governor of the U. S. Zone in Germany, and Gano Dunn, Fellow and Honorary Member ASME, president, J. G. White Engineering Corporation, New York, N. Y., are among five eminent engineers recently elected to honorary membership in the American Society of Civil Engineers.

JAMES O. RICE was recently elected secretary of the American Management Association. Alvin E. Dodd, Fellow ASME, formerly president AMA, has been appointed managing director of the U. S. Associates, an organization of the International Chamber of Commerce which serves as a forum in which American business can express its opinions of international economic problems, preparatory to policy decisions.

ERNEST F. FIOCK, authority in the field of combustion, has been appointed chief of the newly organized Combustion Section of the National Bureau of Standards. The increasing importance of combustion research, particularly its application to gas turbines and jet engines, has made the formation of a separate section devoted to research necessary.

LILLIAN M. GILBRETH, Fellow ASME, president, Gilbreth, Inc., a firm of consulting management engineers, recently was awarded the Woman's Association Award of Eminent Achievement.

T. KEITH LÉGARE, secretary of the National Council of State Boards of Engineering Examiners, is receiving felicitations of friends on the occasion of his 25th anniversary as secretary of the NCSBEE.

Education

TWENTY-FIVE engineering students from many countries of the world recently embarked on a six-month's training program sponsored by the Worthington Pump and Machinery Corporation, Harrison, N. J., as an effort to create and maintain harmonious trade relations with foreign countries.

The students will spend three months at Harrison for complete training on the pumping equipment, feedwater heaters, and water softeners, two months at Buffalo Works on Diesel engines and power-transmission equipment; and will also visit other company plants.

The program is expected to achieve an interchange of technical ideas between the United States and those foreign countries now greatly in need of technical assistance.

Among the countries represented in the program are: Uruguay, China, Chile, Egypt, Cuba, Holland, Siam, France, Mexico, and Canada.

At the conclusion of the six-month period, one additional month will be devoted to those products of the company for which the student has shown a particular aptitude, or which may be of particular importance to the conditions in the student's country.

APPLICATIONS are now being accepted for research grants under the $1,000,000 General Electric Education Fund for the scholastic year of 1949-1950. For the 25th consecutive year, aid in grants up to $1500 annually will be awarded to college graduates who wish to continue individual study and research in scientific and industrial fields.

A STUDENT-RUN "factory" equipped to manufacture a small air compressor by regular mass-production methods will soon be in operation at the school of engineering, Michigan State College, East Lansing, Mich.

The project was planned as a part of a machine-course reorganization necessitated by heavily increased enrollment, particularly of veterans, in the mechanical-engineering curriculum. Original designs for the compressors were executed by a group of students under the direction of Prof. Leonard C. Price, Mem. ASME, during 1947.

The engineering-school foundry is currently producing castings for the machine's various parts from patterns made by students. According to Professor Price, the only parts for the compressor which are not being manufactured by the student factory are highly tooled piston rings and bearings.

S. S. STEINBERG, dean of college of engineering, University of Maryland, returned recently from his good-will mission of two and one half months in Central and South America and the West Indies. He traveled as special representative of Engineers Joint Council and The American Society of Engineering Education under sponsorship of the Department of State, making a survey of engineering education and the engineering profession in Guatemala, El Salvador, Honduras, Nicaragua, Bolivia, Paraguay, Dominican Republic, and Haiti. During the course of his trip he was awarded 10 diplomas, being named honorary professor of the University of San Carlos in Guatemala, the University of El Salvador, the Central University of Honduras, the University of San Andres in La Paz and the Technical University of Oruro, both in Bolivia, the National University of Paraguay, and the University of Haiti. He was also named honorary member of the national engineering societies of El Salvador, Honduras, and the Dominican Republic.

The Mechanical-engineering department leads in the enrollment of 401 students at the new school of engineering of the University of Massachusetts, Amherst, Mass. During the summer 15 men have been added to the engineering faculty, bringing the total faculty to 35, with degrees from 27 engineering colleges and universities. Two engineering buildings are now under construction and funds for a third have been appropriated by the Commonwealth.

New Literature

A BIBLIOGRAPHY on prestressed reinforced concrete containing 190 references to books and articles in publications from all over the world was recently published by the Engineering Societies Library, 29 West 39th Street, New York, N. Y. Called "ESL Bibliography, No. 2," the bibliography supplies annotated references covering all aspects of the subject including theory, design, construction practice, and applications. Price $4.

The Engineering Societies Library's first bibliography which covered filing systems for engineering offices has been well received by the profession. It contains a selected list of 41 references to books and articles on systems of filing. Price $2.

REVISION of the American Standard on "Circular and Dovetailed Forming Tool Blanks and Associated Mounting or Clamping Elements for Holders Used on Automatic Screw Machines, ASA B5.7—1948" published by The American Society of Mechanical Engineers, is now available. The standard covers sizes and types of circular and dovetailed forming-tool blanks and aims to provide interchangeability and a reduction of number of blanks now in use; 15 pages; price 75 cents.

WITH the July, 1948, issue the India Society of Engineers changed the name of its journal to *Science and Engineering.*

THE Southeastern Research Institute, Atlanta, Ga., will commence publication in January, 1949, of a new quarterly scientific journal called *Journal of Southeastern Research.* The journal will report the activities and accomplishments of the 20 university research centers, 10 state engineering experimental stations, and nearly 200 industrial laboratories now operating in the Southeast.

FACTUAL information on aluminum alloys and mill products has been published by the Reynolds Metals Company, Louisville, Ky., in a 162-page book, "Aluminum Alloys and Mill Products Data Book." Complete with 163 tables of data, the book contains information on alloys, tempers, sizes, shapes, physical, chemical, and mechanical properties, and fabricating characteristics. The book is free to engineers who address a request for a copy on a company letterhead to Reynolds Metals Company, 2500 South Third Street, Louisville 1, Ky. To all others, price is $1.

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"HANDLING and Stowage of Ship's Perishable Cargoes, AD 43," published by The American Society of Refrigerating Engineers, 40 West 40th Street, New York 18, N. Y., provides data and describes techniques on the subject; eight pages; price 50 cents.

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"BIBLIOGRAPHIC Survey of Corrosion—1945," by Robert D. Misch, James T. Waber, and Hugh J. McDonald, all of The Corrosion Research Laboratory, Illinois Institute of Technology, Chicago, Ill. Published by the National Association of Corrosion Engineers, 905 Southern Standard Building, Houston 2, Tex. 129 pages, $8^1/_2 \times 11$ inches, cloth; price $5.

Contains approximately 1100 references to published articles relating to corrosion, and 170 references to patents, that appeared from January, 1945, to February, 1946, inclusive, in the following publications: *Chemical Abstracts; Corrosion; Corrosion and Material Protection; Engineering Index; Industrial Arts Index;* and *Metals Review.*

Meetings of Other Societies

December 5-9
The American Society of Refrigerating Engineers, 44th annual meeting, Statler Hotel, Washington, D. C.

December 13-15
American Society of Agricultural Engineers, winter meeting, The Stevens Hotel, Chicago, Ill.

January 10-14
Society of Automotive Engineers, Inc., annual meeting and engineering display, Hotel Book-Cadillac, Detroit, Mich.

January 19-22
American Society of Civil Engineers, annual meeting, Hotel Commodore, New York, N. Y.

January 23-27
American Society of Heating and Ventilating Engineers, 55th annual meeting, Stevens Hotel, Chicago, Ill.

January 31-February 4
American Institute of Electrical Engineers, winter general meeting, Pennsylvania Hotel, New York, N. Y.

(*For ASME Coming Meetings See page 1038*)

ASME NEWS

Materials Handling and Management Divisions to Sponsor Technical Sessions at Third Materials Handling Show

THE third Materials Handling Conference and Exposition planned to demonstrate the opportunity for cost reduction inherent in modern techniques in materials handling will be held at Convention Hall, Philadelphia, Pa., Jan. 10–14, 1949, under sponsorship of The American Society of Mechanical Engineers and the Materials Handling Institute.

The Conference will consist of eight technical sessions sponsored by the Materials Handling and Management Divisions of the ASME. A banquet and a program of films on materials-handling equipment and techniques will be sponsored by the Materials Handling Institute.

Curtis H. Barker, Jr., chairman, ASME Materials Handling Division and general chairman of the Conference, will open the program at the Monday afternoon session. He will be followed by representatives of equipment manufacturers, users of materials-handling equipment, and specialists in transportation techniques, who will appear at sessions each morning and afternoon throughout the week. Among the topics to be discussed will be improvement of methods, case studies in modern materials handling, co-ordination of the materials functions of engineering and management, and others.

The exposition, under the same roof with the Conference sessions will display the products of 200 manufacturers of materials-handling equipment—hand trucks, lift trucks, conveyers, hoists, monorails, portable elevators, stacking units, cranes, tractors, trailers, fork trucks, skids, and pallets and accessories.

The Tentative Program

MONDAY, JANUARY 10

Prologue Session

2:00 p.m.

Message of Welcome, by Curtis H. Barker, Jr., chairman, ASME Materials Handling Division and general chairman of conference; sales manager, Pallet Loader Division, Lamson Corporation, Syracuse, N. Y.

Outlook for the Industry, by Charles F. Roos, president, The Econometric Institute, Inc., New York, N. Y.

Opportunities for Sales Engineering, by Ezra W. Clark, business counselor, consultant on materials-handling methods, Battle Creek, Mich.

The User Talks to the Sales Engineer, by T. O. English, assistant general purchasing agent, Aluminum Company of America, Pittsburgh, Pa.

TUESDAY, JANUARY 11

Opportunities for Management Session

10:00 a.m.

The Importance of Materials Handling, by Curtis H. Barker, Jr, chairman ASME Materials Handling Division

The Economics of Materials Handling, by Stevens H. Hammond, president, The Whiting Corporation, Harvey, Ill.

The Materials Handling Engineer—His Qualifications, His Functions, His Relation to Management, by T. L. Carter, materials-handling engineer, American Cyanamid Company, New York, N. Y.

Improvements in Methods Session

2:00 p.m.

Modern Methods Engineering and Materials Handling, by H. B. Maynard, member, Executive Committee, ASME Management Division

Work-Simplification in Materials Handling, by Allan H. Mogensen, New York, N. Y.

Symposium: Opportunities for Distribution Economics—Industry's Recommendations to Common Carriers

Speakers:

For Industry: Neil Loney, industrial consultant, Detroit, Mich.; formerly materials-handling specialist, Fisher Body Division, General Motors Corporation, Detroit, Mich.

For the Railroads: Fred Carpi, vice-president, traffic, Pennsylvania Railroad, Philadelphia, Pa.

For the Highway Carriers: W. F. White, engineer, Great Southern Trucking Company, Jacksonville, Fla.

The National Point of View: J. W. Milliken, associate editor, *Railway Age*, New York, N. Y.

WEDNESDAY, JANUARY 12

Case Studies Session

9:30 a.m.

Efficient Co-Ordination of Materials-Handling Equipment in a Manufacturing Plant, by C. M. Harris, production manager, Electrolux Corporation, Old Greenwich, Conn.

Applications of Methods Engineering and Equipment Design, by Donald E. Farr, engineering supervisor, Methods Engineering Council, Pittsburgh, Pa.

Ups and Downs of Handling in Multistory Warehouses, by D. O. Haynes, vice-president, Merchants Refrigerating Company, New York, N. Y.

Materials Handling Co-Ordination Session

2:00 p.m.

Panel Discussion

Safety, by D. M. Rush, manager, central planning department, Ansco Division, General Aniline and Film Corporation, Binghamton, N. Y.

Industrial Relations (speaker to be announced)

Cost Control, by Emil Gibian, chief industrial engineer, Thompson Products, Inc., Cleveland, Ohio

Lighting, by Arthur A. Brainerd, illuminating engineer, market studies and applications division, Philadelphia Electric Company, Philadelphia, Pa.

Building Construction (speaker to be announced)

Evening

Banquet

Bellevue-Stratford Hotel

THURSDAY, JANUARY 13

Advances in Technique Session

9:30 a.m.

Automatic Pallet Loading, by M. Landon, engineering department, Sun Oil Company, Philadelphia, Pa.

Equipment—Layout—Operation Processing: Solving Application Problems, by W. J. Dernberger, superintendent, materials-handling engineering, Ford Motor Company, Dearborn, Mich.

Developments in Bulk Handling, by E. A. Wendell, sales manager, Link-Belt Company, Chicago, Ill.

Equipment Session

2:00 p.m.

Symposium:

Developments in Conveyor Design and Application, by R. C. Sollenberger, executive secretary, Conveyor Equipment Manufacturers Association, Washington, D. C.

Developments in Crane, Hoist, and Elevator Design and Application, by A. R. Walkley, general sales manager, Shaw-Box Crane and Hoist Division, Manning, Maxwell, and Moore, Inc., Muskegon, Mich.

Developments in Industrial Truck Design and Application, by Robert Pratt, chief industrial engineer, General Foods Corporation, New York, N. Y.; Lee C. Daniels, chief engineer, Towmotor Corporation, Cleveland, Ohio; and J. C. Erickson, chief engineer, The Elwell-Parker Electric Company, Cleveland, Ohio

Developments in Marking and Stenciling, by H. W. Hempel, vice-president, Marsh Stencil Machine Company, Belleville, Ill.

FRIDAY, JANUARY 14

Materials Handling of Tomorrow

9:30 a.m.

The Biggest Handling Job in the World, by Col. James Glore, Transportation Corps Board, New York Port of Embarkation, Brooklyn, N. Y.

Tomorrow in Air Handling, by Parkman Sayward, general sales manager, Slick Airways, Inc., San Antonio, Texas

Lessons From the Berlin Airlift (speaker to be provided by the U. S. Air Force)

Synthetic Liquid Fuel Oils and Shale Oils Highlight Discussions at 1948 ASME Petroleum Conference

RECENT developments in production of synthetic oil and the oil-retorting method of recovery of shale oil were high lights of the 1948 Petroleum Mechanical Engineering Conference held in Amarillo, Texas, Oct. 3-6, 1948, under sponsorship of the Petroleum Division of The American Society of Mechanical Engineers. A popular annual event which regularly attracts more than 300 engineers and executives of the petroleum industry, the conference was the first sponsored by the ASME petroleum group under its new status as a Professional Division of the Society.

Sixteen technical sessions were held during the three-day period at which 36 technical papers were presented dealing with a variety of subjects pertaining to production engineering, refining, construction materials, refinery equipment, and transportation problems. In each case a lively interest was displayed in the subject under discussion.

Synthetic Liquid Fuels

General aspects of the synthetic liquid-fuels situation in the United States was covered by three papers, the first of which was by W. C. Schroeder, chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C. Problems associated with the Fischer-Tropsch process were discussed by Eugene Ayres, C. W. Montgomery, and Joel H. Hirsch, all of the Gulf Research and Development Company, Pittsburgh, Pa. The third paper, based on the experience of its authors, covered production of liquid fuels from natural gas and was presented by R. C. Alden and Alfred Clark, research staff, Phillips Petroleum, Bartlesville, Okla.

Another session which commanded considerable attention covered the working of Colorado oil shale. One of the papers at this session, entitled "Mining Colorado Oil Shale," was presented by Tell Ertl, Union Oil Company of California which is carrying on this work at Rifle, Colo. Another paper covered oil-retorting methods for the recovery of shale oil. The authors were Homer Reed and Clyde Berg of the same concern who operate out of Los Angeles, Calif.

National Petroleum Reserves

One of the features of the conference was the banquet on Tuesday evening, the speakers being Pres. E. G. Bailey of ASME, and Gen. Ernest O. Thompson, chairman, Railroad Commission of Texas. General Thompson spoke at length on the necessity of building up petroleum reserves which could be made available for immediate use in the event of a future war. He went on to explain that his commission had jurisdiction over the drilling of 206,000 wells in the state, 109,000 of which are still producing. He also stressed the extreme importance of the tidelands issue to his state, as well as to a number of other states similarly situated. General Thompson pointed out that "should war again be waged, America would need in excess of two billion gallons of gas and oil a day and this figure is far beyond what this country can now produce." General Thompson also stated that 10,777 wells in the State of Texas are now producing a total of 19,235,809 barrels of oil monthly on shores adjacent to the Gulf up to the 100-ft surface contour. "It stands to reason the same number of wells could be drilled in the same tidelands area to give the nation much-needed oil," the General declared.

President Bailey called upon engineers to continue their advancements in the field of petroleum which he said plays a great part in the civilization in which we live. "It is not only the privilege but the duty of every engineer to co-operate with industry and our government in some capacity, directly or indirectly, for the betterment of our government," President Bailey declared. "The purpose of engineering is to advance the general welfare of mankind through the available resources and creative ability of the engineering profession."

The presiding officer of the banquet, which was held at the Herring Hotel, was William Raisch, New York consulting engineer, and chairman ASME Petroleum Division. B. B. Morton, metallurgical engineer, International Nickel Company, New York, N. Y., acted as the toastmaster.

Many Enjoy Social Events

In the way of pleasant diversion, a real western barbecue was held at Ranch 6666 which lies some sixty miles outside Amarillo, Texas, this having been sponsored by the Amarillo Arrangements Committee. Except for some difficulty in finding the proper route to reach the location, a pleasant evening was enjoyed. Three Greyhound buses started the trip at the hotel but soon became separated, all traveling in divergent directions. However, after a pleasant tour of a goodly part of the State of Texas for several hours, not to mention the unusual experience of riding through pasture lands in 1948 Greyhound buses, the three units finally converged at the proper location.

An interesting inspection trip was made to the Excell Helium Plant, which is operated by the U. S. Government just outside Amarillo. The visitors, two busloads of them, were pleasantly surprised to witness a splendidly maintained plant operated by the government on an entirely self-sustaining basis. Another tour was also made through the Borger, Fritch, and Buena Vista region where the production of carbon black seems to be one of the principal activities.

Reported by William Raisch.[1]

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[1] Consulting engineer, New York, N. Y., chairman, ASME Petroleum Division.

Woodworking Research and Art of Cutting Woods Discussed at ASME Wood Industries Conference

A SYMPOSIUM on woodworking research and a provocative discussion on the need for a better understanding of the art of cutting woods were the high lights of 1948 Wood Industries Conference of The American Society of Mechanical Engineers held at Sheraton Hotel, High Point, N. C., Oct. 14 and 15, 1948.

Sponsored by the Wood Industries Division of the ASME in co-operation with the ASME Piedmont-North Carolina Section, the conference was attended by 100 engineers in the woodworking industry, who participated in three technical sessions at which a total of 10 papers were presented. A banquet and a tour through the plant of Tomlinson of High Point, N. C., manufacturers of high-quality furniture, completed the program.

Woodworking Research

The symposium on "Woodworking Research; Advantages and Limitations of Each Type" was easily the outstanding session of the meeting. The five types of woodworking research laboratories were briefly described by recognized leaders who are actively engaged in their respective fields.

The Forest Products Laboratory, Madison, Wis., maintained by the U. S. Government in co-operation with the University of Wisconsin, was represented by George M. Hunt, director. He pointed out that their research projects in the wide field of forestry and forest utilization must be of national importance and many of them are in fundamental research. Applied research is also a feature, sometimes sponsored by trade associations or industrial enterprises. Research results are usually published and protection for individual developments is seldom possible. Military developments are an important part of their program, but they are of a restricted nature.

The New York State College of Forestry,

ASME Calendar

of Coming Events

Jan. 10–14, 1949

Third National Materials Handling Exposition and Conference, Convention Hall, Philadelphia, Pa. Technical Program sponsored by ASME Materials Handling Division and Management Division.

April 25–29, 1949

ASME Oil and Gas Power Division Conference, Hotel Sherman, Chicago, Ill.

May 2–4, 1949

ASME Spring Meeting, New London, Conn.

(*Final date for submitting papers—Jan. 1, 1949*)

June 27–30, 1949

ASME Semi-Annual Meeting, San Francisco, Calif.

(*Final date for submitting papers—Feb. 1, 1949*)

Sept. 28–30, 1949

ASME Fall Meeting, Erie, Pa.

(*Final date for submitting papers—May 1, 1949*)

Nov. 27–Dec. 2, 1949

ASME Annual Meeting, New York, N. Y.

(*Final date for submitting papers—Aug. 1, 1949*)

(*For Meetings of other Societies see page 1035*)

maintained at Syracuse, N. Y., as a part of the educational system of the state, was described by Nelson C. Brown, head of the department of forest utilization. He made it clear that their major contribution to woodworking research was the training of able personnel, with a record of some 500 graduates, of whom 15 in turn are teaching in the wood-utilization field. Research problems and industrial surveys, to come within the scope of this institution, must have a definite relation to the citizenry of the state. Many of their projects are sponsored by industry.

The case for the private commercial laboratory was made by Charles Kreider, secretary, representing his chief, Armin Elmendorf, president of the Elmendorf Corporation, Chicago, Ill. It was pointed out that such a private organization could fully protect the interests of clients in any developments or patents, a definite advantage in contrast to tax-supported institutions. It was made apparent that such a private laboratory could be supplemental, for larger projects, to a small laboratory department within an industry. Its staff of scientists is more competent in the wood-utilization field than any industrial departmental laboratory can afford to be.

The fourth type, a laboratory supported by a trade association, was presented by Carl A. Rishell, director of research of the Timber Engineering Company, which is sponsored by the National Lumber Manufacturers Association. It is equipped to handle either affiliated trade-association projects or the problems of commercial organizations under contract arrangements. Combinations of sponsorship are often advantageous.

The last major type presented was that of a research-laboratory department within an industrial organization having a limited staff and equipment, which is constantly available for immediate problems. Such a department can be affiliated with other types of research laboratories for larger problems beyond its scope. The case for this type was made by C. D. Dosker, president of Gamble Brothers, of Louisville, Ky., who gave the most apt definition of the session, terming research a *tool of management*, which has not yet been fully appreciated by the woodworking industry.

The discussion from the floor emphasized that research when properly utilized would give the woodworking industry better protection against competition, larger profits, and a firmer grip on future potentialities.

Co-Operation in Education

Frank J. Hanrahan, chairman of the division, who presided at the evening banquet, introduced the various officers and guests. James T. Ryan, executive secretary of the Southern Furniture Manufacturers Association, served as toastmaster. Henry A. Foscue, vice-president of the Southern Furniture Manufacturers Association, introduced D. E. Henderson, head of the industrial-engineering department at North Carolina State College, who spoke on "Woodworking Education in the South." He cited the need for technically trained personnel in the wood-using industries which involves a $2,800,000,000 over-all business in the southeastern states alone. According to Professor Henderson, educational and industrial collaboration provides the only means of approaching the educational problems of these industries with any degree of success. The speaker summarized the work of the Furniture Foundation, Inc., which is sponsoring the James T. Ryan Professorship in Furniture Manufacture and Merchandising at his institution and cited this foundation as an example of industrial and educational co-operation. Their program of education is aimed at providing better methods and at reducing costs by the elimination of antiquated techniques. After Professor Henderson completed his talk, the Mahogany Association film was shown, telling the story of mahogany from the standing tree to the finished product.

Educational Program

Especially interesting was L. A. Patronsky's paper, "An Educational Program for Wood-Using Industries," presented at the afternoon session. Professor Patronsky discussed in detail the curricula at the University of Michigan. He mentioned not only the courses of study, the equipment, but also gave some idea of the scope of the complete course presented. Substantial progress was indicated in the educational programs designed to acquaint our youth with the practical needs of wood machinery both design and technique.

Weyerhaeuser representative, F. Powell Forbes, of the Weyerhaeuser Timber Company, followed with a paper on the "Fabrication of Structural Members From Timber," showing the progress made in the prefabrication of timber structures. Mr. Forbes stressed the increased faith in this type of construction, as contrasted with the former 100 per cent use of steel.

Next morning A. G. H. Dietz of MIT presented a paper showing the savings to be expected through the use of "Two-Species Laminated Beams." It was a clear discussion of the fundamental theory, carried through to a presentation of relative costs where two different woods are combined in one timber.

MEMBERS OF EXECUTIVE COMMITTEE, WOOD INDUSTRIES DIVISION, AT HIGH POINT, N. C., AT THE WOOD INDUSTRIES CONFERENCE

(*Standing, left to right:* Roger R. Smith, Charles R. Nichols, Jr., C. B. Lundstrom, A. W. Dunbar, and Thomas D. Perry. *Seated, left to right:* F. F. Wangaard, Frank J. Hanrahan, and Elliott D. May.)

Art of Cutting Wood

The paper provoking the greatest discussion was that entitled "Circular-Saw Design, Manufacture, and Operation", prepared by R. D. Brooks, field engineer with E. C. Atkins and Company, Indianapolis, Ind. In his free and easy style Mr. Brooks took the audience along with him in discussing how little is known of how the customers use his company's product, and of the conditions to which saws and cutters are subjected. Apparently there is great need for a set of standards governing the design and use of cutting tools in wood, as was worked out for the metal trades by the late Frederick Taylor. It is to be hoped that the interest provoked by this paper will be the starting point for further work in this direction, under the sponsorship of the Wood Industries Division.

The scarcity of nails and the increasing use of special-formed nails, now being used to replace screws in fastening wood parts, was discussed by E. G. Stern of VPI in his paper on the "Influence of Depth of Penetration on the Withdrawal Resistance of Nails."

Business Meeting

At a business meeting of the Wood Industries executive committee, the following nominations were made: Elliott D. May, chairman, Executive Committee; member, Executive Committee, A. W. Dunbar; member Advisory Committee, Frank J. Hanrahan; members, General Committee, F. Powell and Kenneth Redman; Fire Protection Committee, chairman, Ira C. Funk; members, R. B. Sargent, Horatio Bodn, W. E. McCraw, J. M. Flounders, and Hugh N. McNair.

Society Notes

According to the ASME Constitution, members who pay dues for 35 years or who reach the age of 70 after having paid dues for 30 years are exempt by Council from further dues payments. At present there are 188 in this group; of these 163 are members, 21 Fellows, and 4 associates.

* * *

At a recent meeting of the ARS-ASME Co-Ordinating Committee it was agreed to increase the size of the committee from three to four representatives from each society, and to hold at least four meetings a year. Since the American Rocket Society affiliated with the ASME in 1945, liaison between the two organizations resulted in common policies in such matters as cost of preprints, registration fees, and joint meetings.

* * *

The Industrial Instruments and Regulators is looking with favor to a simplification of its name to the Instruments and Regulators Division.

The matter of judging papers for publications has been given considerable thought by the Professional Divisions Committee. Two forms have been drafted, one for reviewers and the other for Professional Divisions in recommending papers which should go a long way toward systematizing and simplifying rating of papers.

* * *

One of the recent proposals of the Junior Committee is an expansion of the Committee to include five commuting members, eight corresponding members, all junior advisers on national committees, and the Forum editorial committee. Such a structure is expected to keep the Committee in touch with junior members in sections distant from New York, N. Y.

Actions of the ASME Executive Committee

At a Meeting Held at Headquarters, Oct. 22, 1948

A meeting of the Executive Committee of the Council was held in the rooms of the Society on Oct. 22, 1948. There were present: E. G. Bailey, chairman, F. S. Blackall, Jr., F. M. Gunby, E. J. Kates, T. E. Purcell, K. H. Condit, (Organization Committee); K. W. Jappe, Treasurer, James M. Todd, president-elect; A. R. Mumford, vice-president, ASME Region II; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary. F. W. Miller, chairman, Constitution and By-Laws Committee was present during part of the meeting.

Dues of Canadian Members

Upon recommendation of the Finance Committee it was voted that members residing in Canada be permitted to pay their dues in Canadian dollars, if dues for 1948–1949 are paid on or before Dec. 1, 1948.

Dues of Foreign Members

The policy regarding payment of dues by members in foreign countries, other than Canada, adopted on Nov. 25, 1945, was extended for another year unless modified before that time. This policy states that such dues be paid in United States dollars and that members who find payments excessive may request to be placed on a suspended dues list without service from the Society until such time as the Society may require them to pay dues.

Honorary Members

Letter-ballot approval by the Council of election of the following honorary members of the Society was noted: Carl F. Braun, Alhambra, Calif.; Lyman J. Briggs, Washington, D. C.; Oscar A. Leutwiler, Urbana, Ill.; James W. Parker, Detroit, Mich.; and George I. Rockwood, Worcester, Mass.

New Member of Executive Committee

Letter-ballot approval by Council of the appointment of Edgar J. Kates on the Executive Committee of the Council to replace James N. Landis, who resigned, was noted.

Metals Engineering Handbook

Upon recommendation of the Board on Technology, a sum of money was authorized from the Development Fund for preparation of copy for the Metals Engineering Handbook and addition of an associate editor to the present Handbook staff.

Metal Cutting Data

Upon recommendation of the Production Engineering Division concurred in by the Publications Committee and the Board on Technology, it was voted to discontinue publication of *Metal Cutting Data*.

1949 Meetings

Action by the Board on Technology changing dates of the 1949 Spring Meeting from April 25–27 to May 2–4, 1949, at New London, Conn., was noted; also change of the 1949 Fall Meeting from Washington, D. C., to Erie, Pa.

1948 Holley Medal

Edwin H. Land, president, chairman of board, Polaroid Corporation, Cambridge, Mass., was elected to receive the 1948 Holley Medal.

1948 Student Awards

Upon recommendation of the Board on Honors, the following 1948 student awards were approved:

Postgraduate Student Award: To Thomas L. Dinsmore, Princeton University, for his paper "An Experimental Investigation of the Stresses in Eyebars."

Undergraduate Student Award: To Leroy W. Ledgerwood, Oklahoma A&M College, for his paper "Hired Technicians or Professional Engineers."

Charles T. Main Award: To E. Duane Stewart, University of Pittsburgh, for his paper, "The Relation of Invention to Engineering."

1949 Charles T. Main Award Topic

"The Increasing Recognition of Science in Engineering" was approved as the topic for the Charles T. Main Award for 1949.

Resolution of Thanks

A resolution of thanks was adopted expressing on behalf of the Society appreciation and thanks to all organizations and individuals who contributed to the success of the ASME Fall Meeting in Portland, Ore.

Regional Delegates Conference

In order to keep expenses within the budget, the Regional Delegates were requested to hold their annual conference in some Midwestern City rather than at the Semi-Annual Meeting in San Francisco, Calif.

ASME Office Space

A new lease for two years covering office space at 37 West 39th Street, a building adjacent to the Engineering Societies Building on the west, was approved.

Certificates of Award

Certificates of Award for the following retiring chairmen of Sections were approved: James L. Corcoran, Fairfield County; T. E. Smith, Atlanta; J. A. Keene, Birmingham; Max D. Thomason, Piedmont-North Carolina; Henry I. West, Raleigh; C. E. Pond, Virginia; and Harold J. Petersen, East Tennessee. A certificate of award was also approved for Hugh L. Dryden, retiring chairman of the Publications Committee.

Hoover Medal

The award of the 1948 Hoover Medal to Malcolm Pirnie, consulting engineer, New York, N. Y., Mem. ASCE, by the Hoover Medal Board of Award on which the Society has representation, was noted.

A. J. Dickie

The death of A. J. Dickie on August 17, 1948, manager ASME, 1931–1934, was noted with regret.

Appointments

Appointments to boards, committees, and joint activities recommended by the Organization Committee were approved. The list of these appointments may be obtained by writing to Headquarters.

The following additional appointments were approved: H. V. Coes, ASME representative at installation of Pres. Dwight Eisenhower at Columbia University; George I. Rockwood to inauguration of Pres. R. A. Van Meter at University of Massachusetts; Henry T. Heald, to inauguration of Pres. J. H. Davis of Clarkson College of Technology; S. R. Beitler, to 75th anniversary of Ohio State University; R. F. Gagg, to annual inspection, National Advisory Committee for Aeronautics Flight Propulsion Research Laboratory; and G. R. Cowing, ASME representative on EJC Selective Service Committee.

Standardization Procedures Simplified

WITH more than 75 individual standards, codes, and safety rules in process of development by The American Society of Mechanical Engineers, of which 27 are in preparation or revision, the ASME Board on Codes and Standards recently authorized streamlining of Standardization and Safety Committee procedures to eliminate wasteful letter writing, balloting, and delays in matters of personnel appointments.

One of the first changes made was to separate the 24 sectional committees working under ASA procedure into four related groups as follows: Screw threads and gages; (2) machine parts; (3) pipe and fittings; and (4) miscellaneous. Under the chairman of the Standardization Committee each of the four members of the Committee was assigned administrative responsibility for one of the four groups, each composed of from 5 to 8 of the 24 sectional committees. By carrying this division of responsibility down to the staff level, the procedure for arriving at decisions was simplified. Instead of taking time-consuming questions which often delay progress for many weeks before the entire Standardization Committee, staff personnel now have direct access to a sponsor with authority to speak for the Committee in matters of personnel appointments.

Although experience with the new system has been brief, much duplication of effort as well as a considerable amount of letter writing between staff and the Committee and among Committee members themselves has already been eliminated.

At a recent standardization conference held in the rooms of the Society in New York, N. Y., more than 25 members active in ASME standardization work reviewed the entire standardization program and discussed the streamlined procedure under which as many as 15 or more ASME and American codes, standards, and safety rules are expected to be completed and published in 1949.

Code for Pressure Piping to Be Revised Under ASME Sponsorship

THE American Standard Code for Pressure Piping, safety standard for all steam and power services, is to be completely revised within the next two years, according to Frank S. G. Williams, new chairman of the committee which functions under The American Society of Mechanical Engineers' sponsorship. At an organization meeting, Oct. 1, 1948, attended by representatives of more than thirty co-operating bodies, Mr. Williams, who is general manager of the Eastern Division of Taylor Forge and Pipe Works, announced plans for bringing the code abreast of current developments in the field of materials, design, and construction.

Originally organized in 1926, the committee includes representatives of groups primarily concerned with safety of high-pressure piping systems. Members at large are recognized experts in the piping field. Mr. Sabin Crocker, consulting engineer, Ebasco Services, Inc., is vice-chairman, and L. W. Benoit, Manufacturers Standardization Society of the Valve and Fittings Industry, is secretary.

In his charge to the committee, Mr. Williams emphasized the character of the Code as a safety code rather than a design specification. He stressed the need for making periodic interpretations when necessity arises.

Court of Review Function

The present high repute enjoyed by the Code depends on the judicial character of the committee as a court of review. The large membership of the committee represents every reasonable cross section of public interest.

Committee operations will be directed, he explained, by an executive committee composed of chairmen of subcommittees, plus three to five members at large. This group would establish policies, surpervise and co-ordinate, arrange publication and distribution of the Code, administrate the subcommittee work, and maintain liaison with other code-making bodies.

Six Subcommittees Appointed

Specific subcommittees were appointed to revise sections of the Code: (1) Power piping systems; (2) gas and air piping systems; (3) oil piping systems; (4) district-heating piping systems; (5) refrigeration piping systems; (6) fabrication; and (7) corrosion-service piping. A second group of subcommittees include: (1) Materials and stresses; (2) standards and identification; (3) instrument piping; (4) mechanical design; (5) liaison with ASME Boiler Code Committee; and (6) welding procedures and qualifications.

Liaison With Other Bodies Planned

Thus the chairman announced, technical subjects which cross all fields of service, such as instrument piping and mechanical design, will be handled by separate technical committees.

It is proposed to recognize liaison with other code-making bodies as a major function and responsibility to eliminate overlapping of jurisdiction and achieve uniformity. For example, the committee will continue to look to American Society for Testing Materials for solutions to materials problems. A special committee on welding will keep its attention focused on developments in that field that affect the code.

The ASME Boiler Code Committee already has formed subcommittees to establish allowable stresses for materials. It is proposed to co-operate with this group rather than duplicate the activity.

An editing committee is charged with responsibility for uniformity of style and an indexing system for subject matter in each section of the code under uniform numerical references. This subcommittee also reviews incoming questions dealing with interpretation, makes a canvass of opinion among other subcommittees and recommends action to the executive committee. Interpretations may then be published as official interpretations of the code.

Low-Temperature Operation

The field of "corrosion-service" piping is new to the committee. It includes stainless steel, nickel, Inco alloys, aluminum, and copper. These materials, their use and methods of fabrication differ from steel to an extent that separate handling is justified. The chairman also suggested special study of the problems of operation at very low temperatures, below —20 F, not now a part of the code.

The executive committee will meet at six-week intervals until the work is well under way. Address all communications to the Secretary, L. W. Benoit, Manufacturers Standardization Society, 420 Lexington Avenue, New York 17, N. Y.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, A. H. EDELSTEIN, CHAIRMAN

Welcome!

ALL members of the Society join the editors of the Forum in extending hearty congratulations and welcome to more than 1600 young engineers who were elected to junior membership during the past year.

The Junior Forum is published by the Society as a special service to junior members. It is gratifying to note that young engineers are taking advantage of the opportunities for education and professional development which the Society makes available.

During the 1946-1947 academic year 1752 student members transferred to junior membership; during the 1947-1948 year the number rose to 3287. In addition to student-member transfers, 596 nonstudent members in 1946-1947, and 580 in 1947-1948 became juniors; of these 390 were noncollege graduates. Twenty per cent of the applicants with partial college credits were rejected.

These figures are of interest to the Forum. Most of the new juniors are young, fresh out of school; they are starting out in new jobs; probably most of them have served in some branch of the Armed Forces. The Forum wants to know what they want out of engineering; what have been their first impressions of ASME activities in their Section.

Of the large number of new juniors who were not student members, many may be in the older age group. They may have good ideas to contribute to the operation of the Forum and junior groups. Some of the new juniors have several years of industrial experience behind them. What they think of the Society should be not only interesting but helpful.

It is important that the new junior learns of the many Society activities in which he may participate. While section and national meetings are two of the more obvious Society activities, there are many others designed to help the young engineer to grow in his chosen profession. The national Junior Committee and the Forum Editorial Committee, composed of junior members conversant with most of the activities of the Society, stand prepared to answer inquiries from all juniors on matters pertaining to the ASME. Juniors who feel they are not getting enough from the Society, who feel that the Society can improve in services to them, or who wish to know how they can get more out of it by putting more into it are urged to write to these junior agencies. Their ideas and comments will receive prompt and courteous attention. Corresponding members are being sought by both the Forum Editorial Committee and the National Junior Committee. Such service can provide profitable experience in professional activities. Both committees can be reached by addressing communications to Headquarters in New York, N. Y.

Versatility

DESPITE the old adage, don't be afraid to be a "jack of all trades." The modern world needs more of them to tie together the little cells in which the specialists live. Practical versatility is a rare and valuable quality.[1]

Essay Contest for ASME Region I Juniors

TO provide recognition for meritorious achievement and to stimulate thought by young engineers, the Engineering Societies of New England will sponsor an essay contest for their younger members, according to the societies' president, Dean William C. White of Northeastern University.

All members of ESNE who will not have reached their 30th birthday by the deadline date for the submission of essays, March 1, 1949, are eligible to compete. Cash prizes totaling $100 will be awarded to the winning contestants. The essay topic is "The Obligations of the Engineer to a Free Society."

"Know Thyself"

MORE and more modern corporations are "looking to engineers for their managers because they find the engineering training and method of thinking suitable," Robert Paxton, Mem. ASME, manager, transformer division, General Electric Company, Pittsfield, Mass., told graduating engineers at the 139th commencement at Rensselaer Polytechnic Institute last September.

He warned, however: "Technical proficiency is seldom enough. Technical failure is not commonly the real reason for failure among engineering apprentices. Failure to have a liking and respect for people as such, failure to be a teamworker, and failure to give generously of credit and praise to associates is so often the real reason.

"The engineer must analyze himself as objectively as he would any technical problem. He must broaden his studies to include psychology and economics. If he is going to be very useful as a citizen, he must interest himself in government and civic affairs."

He said that 25 years ago when he was a student at Rensselaer, the students talked about "losing ourselves in a big corporation." But today's corporation, he said, was not a "giant business but an assemblage of smaller ones," in which the young engineer finds himself "protected by the greater financial stability of the aggregate" and in which he can freely consult with his manager. The manager's office, he stated, "no longer carries the 'strictly private' legend."

Comment

Engineer-Employer Relationship

To the Editor:

I HAVE read every installment of the new Junior Forum, and believe it is the best step taken for years by the Society—a renewed accent on the importance of youth's problems at the primary end of our profession and business group.

When the Forum is resumed, the present situation in junior engineer-employer relationships should be thoroughly aired and discussed. It seems that with the great majority of industrial concerns we are expected to be professional in thought and actions, while in pay and working conditions we are not always equal to many skilled and semiskilled workers in the same company or plant. Also, the number of concerns which encourage professional activity in engineering societies is far too small; as is the number of those who treat engineers as individuals doing important work, rather than "just another employee." I would say that the chief cause of dissatisfaction and turnover among junior engineering personnel is because of the low professional morale and poor working conditions for engineers which exist in so many industries today.

Finally, doesn't this all result from our failure as engineers to sell industry on the value and profit of our services when properly handled and administered? I personally know of nothing so salesworthy which has been so undersold.

JACK B. MORRIS.[2]

Job Opportunities

To the Editor:

I have just finished reading ASME Junior Forum in the October, 1948, issue of MECHANICAL ENGINEERING and cannot help but feel that some of the articles in it were quite misleading. I am especially referring to "Is There Elbow Room in Engineering?" and "Which Job for the Graduating Engineer?" In the latter article, the writer says, "Today the senior student may sit back and with a certain amount of smugness, pick and choose to his heart's desire" (pertaining to job offers). If that quotation also applies to junior engineers who have just graduated (as it must!) from school, I would say that it is completely in error. My experience in the last few months would indicate that there are few or no openings available for young engineers without experience. I graduated this June from the University of Michigan with a 2.75/4.00 average (upper $^1/_3$ of class) and then searched up and down New York City and vicinity for a position as well as wrote to a great number of firms and listed myself with every engineering employment agency (including Engineering Societies Employment Service) in New York City. Whether one visited or wrote to a firm or agency, the answer was the same—nothing available right now for men without experience. While I am no "handsome Joe" I am fairly respectable and intelligent looking and so presume that did not affect all my visits.

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[1] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Mem. ASME.

[2] Planning Engineer, National Cash Register Company, Dayton, Ohio, Jun. ASME.

Further evidence of what I have said may be found if you will turn to page 862 of October or any other issue of MECHANICAL ENGINEERING. The "Positions Available" page means nothing for the inexperienced engineer. Don't you believe the readers of Junior Forum should get a more truthful picture of the job situation than the rather rosy one always painted there? If the situation is any different from that which I have painted, I'd certainly like to hear about it.

DAVID HOWARD WEISS.[3]

Book Review

Engineering Education

TRENDS IN ENGINEERING EDUCATION, THE COLUMBIA EXPERIENCE.[4] By James Kip Finch. Columbia University Press, New York, N. Y., 1948. Cloth, $5^1/_2 \times 7^3/_4$ in., 140 pp., $2.

REVIEWED BY GLENN R. FRYLING[5]

FULFILLING a long-felt need for an overall approach to the problems of engineering education is this brief volume by the Dean of the School of Engineering at Columbia University. It should appeal to all engineers—young and old—who maintain an active interest in the process of engineering education, and to those who have lost that interest "Trends in Engineering Education" may well serve as an incentive for becoming acquainted with recent developments in professional training. Certainly this modest but convincing book deserves the widest possible attention within the ranks of the engineering profession.

Especially to be commended are two of the approaches used by the author. Although his book is concerned with but one engineering school, Columbia, Dean Finch finds this no limitation and makes effective use of historical perspective in focusing attention upon contemporary problems of engineering education in an admirably organized chapter entitled "The Background of American Engineering Education." Secondly, the author exhibits a sympathetic awareness of the problem of general education as related to engineering training. Drawing upon a quarter century of experience of collaboration with Columbia College, he illustrates vividly the manner in which co-operation and integration of purpose have been achieved between the liberal arts and engineering schools of his own institution.

Deserved attention is accorded to the field of fundamental engineering science. Popular use of the word "science" and the adjectives "pure" and "applied" has obscured the major accomplishments of the engineering profession in developing such fields as fluid mechanics and stress analysis, accomplishments which of themselves have contributed to the natural sciences. In the words of the author "Throughout the ages engineers have gained better understanding of their problems and improved their power and techniques, through work of the pioneers in science. Conversely, not only has natural science received valuable contributions through engineering experiences and studies but no inconsiderable part of the support which science has secured today has come from its engineering relationship." Thus American engineering educational institutions have a responsibility to further the advancement of basic-engineering knowledge.

To this young engineer the weakest chapter in the presentation by Dean Finch concerns "The Student." The latter seems to be viewed from the Olympian heights of an academic hierarchy which hovers above the level of the very real problems of adjustment of the maturing student undergoing training for the engineering profession. Little attention is accorded to so-called "professional adjustments" and to the role of the student branches of the engineering societies in school affairs. In making engineering education more effective, curricular and extracurricular activities emphasizing professional responsibilities, ideals, and aspirations deserve far more consideration on the part of both the engineering schools and the professional societies.

Of particular interest to those who are in the early stages of professional-engineering careers is a commendable chapter entitled "Post-Graduate Needs and Problems." In it Dean Finch discusses problems of continued education after graduation for the young engineer and of developing means of furthering instruction and guidance in labor relations. Finally the author devotes a brief chapter to the development of a philosophy of engineering education, "Some Educational Contradictions." Both of these chapters develop thoughts vital to both engineering education and practice. "Trends in Engineering Education" may best serve its purpose if it inspires other engineers to follow the path it has trod and to express in writing their realistic thoughts concerning engineering education.

New Publication Plan

THE new publication plan has been in effect for eleven months. In general, the plan has worked well. Some modifications have been suggested to the Publications Committee and these will be considered early in 1949 when the whole scheme is reviewed by the Board on Technology.

In the meantime, an effort has been made to make it convenient for members to obtain preprints in advance of meetings. As soon as papers are received at headquarters, code numbers are assigned. These identify the meeting at which the paper will be presented, the year of the meeting, and the order in which it was received. For example, an annual meeting paper might have some number as 48—A-50. To the member ordering the paper and to all the staff personnel processing papers and filling orders, this number means that the paper was prepared for the 1948 Annual Meeting and that it was the 50th paper received for that program. Not only does the number offer a convenient handle for picking up any one of more than 400 papers contributed annually to the ASME, but it facilitates filing and storage, considerations upon which efficiency or lack of it in filling orders depends.

Members will serve themselves better if they order papers by number. These now appear on final programs distributed at meetings, tentative programs published in MECHANICAL ENGINEERING, and in the digests appearing in "ASME Technical Digests."

The order department at headquarters has been enlarged to handle the increase of orders stimulated by the new plan. Since members are entitled to a 20 per cent discount on ASME literature, it is well to indicate on orders whether you are a member. Otherwise the order is set aside for a check, while orders on which there are no questions of membership status are filled.

Perhaps the greatest time savers in the ordering and handling of preprints are the coupon books. If you have not yet availed yourself of these, give them a try. They proffer emancipation from the tyranny of the checkbook and the postal money order. The coupons sold in books of ten at $2 to members, and $4 to nonmembers, not only save you money because they are worth $2.50, but they are legal tender when it comes to purchasing preprints and reprints of ASME papers. Paste them on your order. They serve you as simply as that.

One of the major benefits of the new plan is the availability of digests of papers presented at Societies National Meetings. In the November issue of MECHANICAL ENGINEERING 13 digests of Annual Meeting preprints were published, in this issue 34 appear, and it is expected that in the January issue along with a report of the Annual Meeting, members will have available to them, digests of more than half of the technical papers presented. When the plan is further perfected, it will no longer be necessary to wait many months for the substance of important papers.

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[3] Jun. ASME, New York, N. Y.

[4] Another review of this book will be found on page 1024 of this issue.—EDITOR.

[5] Mechanical Engineer, Westcott and Mapes, Inc., 109 Church Street, New Haven, Conn. Jun. ASME.

CENTRAL ILLINOIS SECTION HONORS AN ASME FELLOW

(At the ceremony before ASME Central Illinois Section on Sept. 23, 1948, C. G. A. Rosen (*right*) was presented a gold fellow membership card and a fellowship certificate from T. S. McEwan, (*center*) vice-president, ASME Region VI. Mr. Rosen is director of research, Caterpillar Tractor Company, Peoria, Ill. Also shown is T. J. Dolan, professor, University of Illinois, and chairman of the ASME Central Illinois Section)

Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

1948 Semi-Annual Meeting Publicity

THE importance of having the texts of luncheon speakers and authors well in advance of a national meeting of the Society was again emphasized in a comparative analysis of publicity results of the 1947 and 1948 ASME Semi-Annual Meetings submitted recently by George A. Hastings, publicity director ASME.

For the Milwaukee meeting only two of the advance texts of speakers were available, whereas for the 1947 Semi-Annual Meeting, all five of the luncheon and dinner speakers provided advance texts which were subjects of advance releases.

This and other factors explain in part a drop in newspaper and magazine publicity for the Semi-Annual Meetings from 153 columns in 1947 to 90 in 1948.

New MECHANICAL ENGINEERING Release Date

THE first of the month has been accepted as the date of issue of MECHANICAL ENGINEERING in the face of conditions in the publishing industry which have made it impossible during the past nine years to meet the old date, which was the 25th of the preceding month. Abandonment of the 25th date was forced upon the Society by the drift among industrial advertisers to the practice of releasing copy for a first-of-the-month date of issue.

The new date means that members can no longer expect to receive the magazine by the first of the month as was the case before the War. Depending on the distance of the member's home post-office from Easton, Pa., MECHANICAL ENGINEERING must be considered "on time" if received during the first week of the month.

Section Activities

REPORTS of the following ASME Section Meetings were received recently at Headquarters:

Akron-Canton, Oct. 18. Inspection trip to deep limestone mine. Attendance: 21.

Baltimore, Oct. 25. Speaker: Dr. George F. Wislicenus. Attendance: 146.

Boston, Oct. 28. Speaker: Robert G. Dexter. Attendance: 235.

Buffalo, Oct. 20. Speakers: A. A. Nime, B. E. Carroll, and G. L. Martin. Attendance: 98.

Central Illinois, Sept. 23. Speaker: Thomas S. McEwan, vice-president, ASME Region VI. Attendance: 49.

Central Indiana, Sept. 11. Annual family picnic for members, wives, and children. Attendance: 50.

Oct. 22. Speaker: Dr. R. W. Dayton. Attendance: 149.

Chicago (Junior Group), Oct. 12. Speaker: R. A. Budenholzer. Attendance: 103.

Cincinnati, Oct. 7. Speaker: Gustav A. Gaffert.

Cleveland, Oct. 14. "Get Together" meeting. Attendance: 52.

Colorado, Oct. 15. Speaker: E. G. Bailey, president ASME. Attendance: 56.

Columbus, Sept. 28. Panel discussion. Moderator: R. A. Sherman. Attendance: 65.

Oct. 26, Junior Group. Speaker: C. H. Van Hartesveldt. Attendance: 83.

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Address of Employer.. ☐
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Product or Service...

Position or Title...

Notify Headquarters Promptly of Changes

Detroit, Oct. 12. Speakers: R. E. Esch and J. W. Brennan. Attendance: 175.

Erie, Oct. 13. Speaker: Alan Howard. Attendance: 86.

Fairfield County, Oct. 19. Speaker: Dr. E. E. Minett. Attendance: 148.

Greenville, Oct. 8. Speaker: Ralph Fiel. Attendance: 73.

Hartford, Oct. 19. Speaker: Charles H. Kaman. Attendance: 150.

Kansas City, Oct. 20. Speaker: E. G. Bailey, president ASME. Attendance: 80.

Milwaukee, Oct. 13. Speakers: C. D. Wilson and Hans Dahlstrand. Attendance: 85.

New London, Oct. 21. Speaker: Kenneth Sherman. Attendance: 75.

Ontario, Oct. 14. Speaker: R. N. Pond. Attendance: 170.

Philadelphia, Oct. 26. Speaker: M. D. Engle. Attendance: 254.

Piedmont-North Carolina, Oct. 14. Business meeting. Attendance: 10.

Providence, Oct. 14. Speaker: Benjamin P. Graves. Attendance: 75.

St. Louis, Sept. 24. Annual Smoker. Attendance: 150.

San Francisco, Oct. 12. Speaker: E. G. Bailey, president ASME.

Savannah, Oct. 13. Speaker: T. Keith Lègare. Attendance: 77.

Southern California, Oct. 21. Speaker: L. K. Spink. Attendance: 165.

Southern Tier, Sept. 27. Speaker: Prof. Chas. O. Mackey.

Oct. 20. Speaker: C. C. Tyrrell. Attendance: 19.

South Texas, Oct. 14. Junior Group program. Speaker: Stanley Moore. Attendance: 29.

Oct. 29. Inspection tour of Humble Oil and Refining Company's plant. Attendance: 184.

Syracuse, Oct. 6. Speaker: M. H. Pratt. Attendance: 31.

Tri-City, Oct. 26. Inspection of Riverside power station, Bettendorf, Iowa. Attendance: 35.

Washington, D. C., Oct. 14. Speaker: John M. Hodge. Attendance: 49.

Western Washington, Oct. 6. Field trip through Pacific Car and Foundry plant. Speaker: Frank E. Stewart. Attendance: 69.

Worcester, Oct. 7. Speaker: Prof. L. J. Hooper. Attendance: 35.

Youngstown, Sept. 9. Speaker: Thomas L. White.

Oct. 13, Speaker: L. A. Chacey. Attendance: 39.

Student Branch Activities

Reports of the following ASME student branch meetings were received recently at Headquarters:

University of Akron, Oct. 12. Election of officers. Attendance: 60.

Oct. 28. Program of two short films. Attendance: 36.

Alabama Polytechnic Institute, Oct. 4. Film on Diesel engines shown. Attendance: 55.

Bucknell University, Oct. 7. Election of officers. Attendance: 48.

California Institute of Technology, Oct. 11. Speaker: E. G. Bailey, president ASME. Attendance: 65.

University of California, Sept. 24. First meeting of the new school year. Attendance: 135.

Catholic University of America, Oct. 28. Speaker: Thomas T. Neill. Attendance: 66.

Clarkson College of Technology, Sept. 29. First meeting of school year. Attendance: 130.

University of Colorado, Oct. 5. Speaker: Dr. John Evans. Attendance: 160.

Cooper Union (Day School of Engineering), Oct. 19. General meeting. Attendance: 23.

Oct. 25. Speaker: Mr. Dougherty. Attendance: 91.

Cornell University, Oct. 5. Speaker: Dean Emeritus, Dexter S. Kimball. Attendance: 100.

University of Detroit, Oct. 6. Speaker: Henry S. Walker. Attendance: 175.

Drexel Institute, Oct. 6. Renewal of membership and admittance of new members. Attendance: 87.

Oct. 20. Speaker: George Reeves. Attendance: 36.

Duke University, Oct. 12. Presentation of committee reports. Attendance: 36.

Oct. 19. Speaker: Mr. McGee. Attendance: 85.

University of Idaho, Sept. 28. Showing of film on Rudolf Diesel. Attendance: 46.

Illinois Institute of Technology, Oct. 12. Speaker: Harold V. Hawkins. Attendance: 250.

Oct. 21. Trip to Wisconsin Steel Division, International Harvester Company's plant. Attendance: 150.

University of Illinois, Sept. 22. Speaker: Prof. W. N. Espy. Election of officers. Attendance: 182.

Iowa State College, Oct. 15. Speaker: Don Bermann. Attendance: 119.

State University of Iowa, Oct. 6. Election of officers.

Oct. 13. Showing of film on the atomic bomb.

Oct. 20. Speaker: Prof. Jack Johnson.

Johns Hopkins University, Oct. 8. Film shown by courtesy of Glenn L. Martin Company. Attendance: 70.

Kansas State College, Oct. 8. Meeting of senior ASME group. Attendance: 55.

Oct. 18. Speaker: E. G. Bailey, president ASME. Attendance: 250.

University of Kentucky, Oct. 7. Brief speech by Professor Carter, honorary chairman.

Oct. 14. Speaker: Mr. Stille.

Oct. 21. Film on atomic energy.

Lehigh University, Sept. 30. First meeting of the school year. Attendance: 85.

Oct. 21. Speaker: Prof. C. D. Jensen. Attendance: 52.

Louisiana State University, Sept. 28. Election of officers. Attendance: 55.

Oct. 5. Special meeting. Showing of two films. Attendance: 35.

Oct. 12. General business meeting. Attendance: 111.

University of Louisville, Oct. 14. Speaker: C. N. Bentley. Attendance: 105.

University of Maine, Oct. 20. Election of officers and showing of slides on gas-turbine and jet-engine operation. Attendance: 51.

Marquette University, Sept. 23. First meeting of fall quarter. Attendance: 76. ASME student branch at Marquette University on field trip to plant of the Carnegie Steel Corporation.

Michigan State College, Oct. 6. Speaker: L. C. Price. Attendance: 210.

Oct. 20. Speaker: Lawrence F. Hope. Attendance: 106.

University of Michigan, Oct. 13. Speaker: Dr. E. F. Barker. Attendance: 135.

University of Minnesota, Oct. 6. Speaker: Lyle Borst, Mem. ASME. Attendance: 281.

Mississippi State College, Oct. 7. Showing of film on electric arc welding. Attendance: 52.

Missouri School of Mines, Oct. 5. Speaker: M. A. Elliot. Attendance: 170.

Oct. 19. Speakers: James Timlin, student, and Richard Duncan. Attendance: 135.

University of Nebraska, Sept. 29. Speakers: Prof. Niles Barnard and R. W. Mills. Attendance: 180.

University of Nevada, Sept. 28. Speaker: Weld Arnold. Attendance: 22.

Oct. 13. Speaker: E. G. Bailey, president ASME. Attendance: 58.

University of New Hampshire, Oct. 8. Speaker: Dean Lauren E. Seeley. Attendance: 86.

New Mexico State College of A & M Arts, Sept. 21. Election of officers. Attendance: 30.

Sept. 30. Speakers: Professor Lukens and Professor Panlener. Attendance: 60.

Oct. 7. Speaker: Jack T. Wilson. Attendance: 140.

Oct. 21. Appointment of committees for annual Homecoming Day celebration. Attendance: 75.

New York University (Day) Oct. 21. Speaker: Prof. Austin H. Church. Attendance: 225.

Northeastern University, Sept. 29 and October 14. Speaker: Mr. Fava; also technicolor film on resistance welding. Attendance: 61.

University of Notre Dame, Oct. 7. New officers introduced and committees appointed; showing of two films. Attendance: 61.

Oct. 21. Showing of film on oil in Arabia. Attendance: 65.

Ohio State University, Oct. 7. Speaker. Roland Holmes. Attendance: 110. Oct. 21. Speaker: Prof. Wilson R. Dumble. Attendance: 126.

Oklahoma A & M College, Oct. 11. Speaker J. R. Haskins. Attendance: 70.

Oct. 25. Speaker: Max Wise. Attendance: 32.

University of Oklahoma, Sept. 24. Speaker: E. G. Bailey, president ASME. Attendance: 421.

Oct. 27. General meeting. Attendance: 60.

Oregon State College, Sept. 30. Speaker: John Foster. Attendance: 50.

Pennsylvania State College, Oct. 7. First meeting of the year. Speaker: Dean H. P. Hammond. Attendance: 250.

Polytechnic Institute of Brooklyn (Evening), Oct. 4. Speakers: Prof. Ernst L. Midgette and A. R. Mumford, vice-president, ASME Region II. Attendance: 45.

Pratt Institute, Sept. 29. First meeting of the school year. Attendance: 123.

Oct. 15. Showing of film on importance of the properties of gasoline in aircraft engines. Attendance: 62.

Princeton University, Sept. 30. Program: Two sound movies. Attendance: 38.

Rice Institute, Sept. 30. Speaker: Allen Rhoades. Attendance: 36.

Oct. 18. Speaker: O. H. Moore. Attendance: 43.

Rhode Island State College, Oct. 7. Enrollment meeting. Attendance: 82.

University of Southern California, Sept. 22. First meeting of the fall semester. Attendance: 56.

Oct. 11. Speaker, E. G. Bailey, president ASME. Attendance: 95.

Stanford University, Sept. 30. Speaker: Dave Casto.

Oct. 12. Speaker: E. G. Bailey, president ASME.

Swarthmore College, Oct. 5. First meeting of academic year. Attendance: 45.

University of Tennessee, Oct. 6. General meeting with elections. Attendance: 110.

Oct. 13. Film showing Yarway's steam traps, expansion joints, and other products. Attendance: 37.

Oct. 27. Speaker: Robert A. Chandler. Attendance: 71.

A&M College of Texas, Sept. 17. Election of officers.

Oct. 13. General meeting. Attendance: 52.

Tufts College, Oct. 6. Speaker: William F. Kuyper. Attendance: 70.

Oct. 15. Official opening of new General Motors plant, Framingham, Mass.

Oct. 26. Plant trip to Watertown Arsenal.

Vanderbilt University, Oct. 6. Election of officers. Attendance: 104.

Oct. 20. Showing of film on football. Attendance: 80.

Virginia Polytechnic Institute, Sept. 29. Showing of two films. Attendance: 198.

Oct. 5. Business meeting. Attendance: 190.

Oct. 12. Showing of film on plastics. Attendance: 195.

Oct. 19. Business meeting. Attendance: 201.

Washington State College, Sept. 30. Speakers: Mr. Candee, honorary chairman, and Dr. Sorenson of the college faculty. Attendance: 62.

University of Washington, Oct. 7. Speakers: Dean Wessman, Prof. B. T. McMinn, Prof. L. B. Cooper, and Prof. R. W. Crain. Attendance: 130.

Wayne University, Oct. 7. Speakers: Frank Montana and Suren Pilafean, designers of the new State Hall, classroom building. Attendance: 48.

University of Wisçonsin, Sept. 28. Speakers: Mr. Nordley and Mr. Swannack. Attendance: 90.

Oct. 26. Speaker: Arthur F. Erwin. Attendance: 89.

Worcester Polytechnic Institute, Oct. 19. First meeting of the year and showing of film. Attendance: 123.

University of Wyoming, Sept. 28. Speaker: Mr. Lindahl, honorary chairman. Attendance: 45.

Yale University, Sept. 29. Opening meeting of the season. Attendance: 40.

Oct. 7. Speaker: Prof. Roland Meyerott. Attendance: 32.

ASME Sections

Coming Meetings

Atlanta: December 17. Athletic Club Dining Room at 6:30 p.m. Christmas Party. P. H. Nichols in charge.

Cincinnati: December 2. Engineering Societies Building. Dinner at 6:30 p.m. Meeting at 8:00 p.m. Subject: Heat Transfer Problems. Speaker to be announced, Stewart Warner Company.

Greenville: December 13. S&W Cafeteria, Asheville, N. C. at 7:00 p.m. Annual joint meeting with the Engineers' Club of Western North Carolina. Subject: Coal, by Julian E. Tobey, president, Appalachian Coals, Inc., Cincinnati, Ohio.

Hartford: December 21. City Club at 6:30 p.m. Executive Committee meeting.

Kansas City: December 13. University Club. Dinner at 6:30 p.m. Meeting at 8:00 p.m. Subject: Your Society and You, by Linn Helander, vice-president ASME, Region VIII.

Minnesota: December 1. Section meeting. Subject: The Challenge to Modern Science, by Dr. Mark Granbard, associate professor of natural science, University of Minnesota.

North Texas: December 7. Procter and Gamble Manufacturing Company at 8:00 p.m. Inspection of plant.

Peninsula: December 14. Section meeting. Subject: A Phase of ASME Activities. Speaker to be announced.

Philadelphia: December 7. Towne School, University of Pennsylvania at 8:00 p.m. Subject: The Evolution of the Pressure System for Hydraulic Presses, by R. G. Tabors, sales manager, Hydraulic Press Department, Baldwin Locomotive Works.

December 14. Edison Building, 900 Sansom Street, Philadelphia Electric Company at 7:30 p.m. Subject: Schuylkill River Restoration Project, by Commander Edmund S. Mc Cawley, deputy secretary, Department of Forests and Waters, Commonwealth of Pennsylvania.

St. Louis: December 17. Garavelli's Restaurant. Dinner at 6:30 p.m. Meeting at 8:00 p.m. Subject: Control and Production of High Carbon Wire, by J. G. Weiss, foreman, Patenting and High Carbon Wire Department, Keystone Steel and Wire Company, Peoria, Ill.

Virginia: December 7. Joint meeting of the Blacksburg-Roanoke Section with Virginia Polytechnic Institute student branch at Blacksburg, Va.

December 8. Joint meeting of Charlottesville-Waynesboro Section with the student branch of University of Virginia at Charlottesville, Virginia.

December 9. Joint meeting of the Peninsula Chapter ASME (Sub-section), Engineers Club of Virginia, Peninsula and Virginia Section AIEE at Newport News, Va.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 East Randolph Street	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

INDUSTRIAL ENGINEER, 38; ten years' experience of twenty in manufacturing. Desires position as production or works manager. Experience in variety of industries, particularly machinery manufacturing. Boston-Providence area. Me-354.

MECHANICAL ENGINEER, 26, single; three years oil company, general construction, office, and field; one year aircraft-engine-gear development. Member three honor societies. Prefers opportunity to security. Available February 1, 1949. Pacific Coast. Me-355-484-D-9.

ENGINEER-MANAGER, project management, development, design, construction, and operation. Chemicals, oil refining, coal, and gas. Twenty-five years' experience; chemical; mechanical; and administrative. Me-356.

CHIEF DEVELOPMENT ENGINEER. Responsible for experimental design, extensive laboratory and experimental shop, staff over 100 doing exacting mechanical-development work;

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[1] All men listed hold some form of ASME membership.

desires similar position, or executive post in smaller firm in eastern states. Me-357.

Industrial-Mechanical Engineer, ME; plant engineering, design, time study, material handling, cost accounting, plant management, and administrative experience. Will send résumé of experience in bakeries, roofing, soap, and atomic industries. Any location in U. S. A. Me-358-8-M.

Staff Executive on Management or Chief Industrial Engineer, 36. Engineering executive with wide background of fourteen years on staff-management work, consulting, industrial engineering, and production. Experience has been of high professional character with original and practical application of sound engineering and management principles. Me-359.

POSITIONS AVAILABLE

Director of Engineering, mechanical or electrical engineer, with background in light manufacturing. Proved ability in research, design, and development of small mechanical-electrical products for mass production. Familiar with drafting, model procedures. An organizer capable of co-ordinating product research and development with manufacturing and sales requirements. $10,000–$12,000. New England. Y-1425.

Engineers. (*a*) Chief mechanical engineer to supervise engineers and draftsmen on the layout and design of industrial-laboratory buildings. (*b*) Electrical engineer with experience as above. $8400–$9600. New York, N. Y. Y-1669 (*a*).

Development Engineer, electrical or mechanical graduate, with ceramic experience in electrical industry, for development project on dielectric condensers. $5000–$6000. Pennsylvania. Y-1689.

Mechanical Engineer, 30–40, with sales and service or operating experience in boiler-combustion field, to perform office duties and make sales and service calls covering boiler-cleaning accessories. $4000–$5000. New York metropolitan area. Y-1696.

Design Engineer, 28–35, mechanical graduate, with mechanical, electrical, and pneumatic-equipment design experience, to supervise draftsmen and design special apparatus in soot-blowing field. $4200–$5400. Pennsylvania. Y-1697.

Director, School of Mechanical Engineering, 35–45, mechanical graduate. Must have aptitude for technical writing. At least eight years' experience in the field of mechanical engineering, to supervise employees who correct lesson papers received from students; to revise, write, and edit instruction pamphlets and lesson texts to be used for correspondence instruction in mechanical-engineering subjects. $4000–$4200. East. Y-1699.

Senior Mechanical Engineer, graduate, with not less than ten years' experience in design and operation of hydraulic turbines, penstock valves, and associated power-plant accessories. Work involves mechanical plant layout, preparation of specifications, examination of manufacturers' drawings, and inspection of equipment. Salary open, depending on qualifications. Canada. Y-1721.

Mechanical Engineer, 28–45, BSME with about five years' experience in plant maintenance and operation studies, work scheduling, fuel specifications, and time study. Must have demonstrated supervisory and planning ability. $4400–$5500. Maryland. Y-1724.

Salesman, 2, under 35, with industrial selling ability, preferably having steel experience, to call on industrial plants for a steel-tubing distributor. Locations, one to cover the New England territory, and the other to cover upper New York State area, preferably residents of these territories for some years. Travel 50 per cent of time. $4000 plus traveling expenses. Car furnished. Y-1728.

Mechanical Engineer, graduate, with about five years' experience in mechanical development of cameras with some working knowledge of electricity for development and design of camera mechanisms in connection with tracking instruments. About $5200. New York, N. Y. Y-1743.

Plant Manager, 30–40, preferably mechanical graduate, capable of assuming the full responsibility of maintaining all machines, equipment, and the building in first-class condition to produce the highest-quality product for a paper mill. $5000, depending upon qualifications. Indiana. Y-1754-C-D.

Methods Engineer, 30–40, industrial or mechanical degree, with at least five years' experience in food-industry-methods work. Should be able to work with people. $5000–$6000. Maryland. Y-1763.

Mechanical Engineer, young, graduate, experienced, with some work on air and gas compressors, or similar reciprocating machinery. Will be trained to make compressor computations involving performance, stresses, etc., and do specialized designing on compressors, valves, etc. Good knowledge of mathematics required. Permanent. Salary open. Pennsylvania. Y-1773.

Mechanical Superintendent, thoroughly familiar and experienced in tool-design work. Must be well acquainted with toolroom practice and be able to supervise toolroom. Must be familiar with the design and construction of special equipment, and have general knowledge of plant machinery and equipment. $6000. Westchester County, N. Y. Y-1782.

Mechanical or Civil Engineers, preferably experienced in pulp and paper mills, but general construction experience on industrial buildings and installation of heavy machinery such as chemical-plant equipment will be considered. Positions involve the field end of construction work on planning, scheduling, and expediting of the projects; including checking on work progress, field efficiency, etc. Up to $4500, depending upon qualifications. Maine. Y-1783.

Sales Engineer, 30–40, mechanical graduate, with industrial sales experience in northern New Jersey, eastern Pennsylvania, and southern New York, to represent manufacturer of leather products and power-transmission equipment. $5000–$6000. Y-1785.

Sales Engineers, mechanical graduates, with considerable experience in steam power plants, for the sale of valves, expansion joints, indicators and recorders, traps, strainers, etc. Minimum of 3 to 5 years' experience for New York territory; 1 to 3 years' experience for Boston and Cincinnati territories. Salaries open. Y-1786.

Sales Engineer, combustion engineer, graduate mechanical or electrical, young, recent graduate with power-plant experience. Will test coal in power plants, industrials, and utilities. About $3000. Headquarters Chicago; 5 per cent of time spent in traveling. R-5277.

Chief Engineer, designer, up to 50, extensive experience in design of heavy mechanical equipment (hoists, earth moving, sawmill, licks, valves, welding, paper mill) cost, estimating plant-production knowledge. Will design from receipt of order through shipment, breakdown, material requisitions, estimating routing through shop. Plant employs 500, six to ten draftsmen; equipped as heavy-equipment general machine shop for custom-built products. Designs must conform with plant limitation. Long-range-program plant rehabilitation in effect. About $10,000. Oregon. R-5290.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after Dec. 25, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Abbott, George Arthur, Lansing, Mich.
Adgar, Dudley C., New York, N. Y.
Anderson, A. L., Detroit, Mich.
Andrews, J. Lewis, Fairfield, Ill.
Arthur, John B., Montebello, Calif.
Baker, Wilfred Edmund, Baltimore, Md.
Balson, Seymour Morris, Brooklyn, N. Y.
Becker, D. B., Fort Atkinson, Wis.
Berghoff, H. L., Ann Arbor, Mich.
Best, Edward J., Glenbrook, Conn.
Bhote, Homi Maherwanji, Philadelphia, Pa.
Bleibtreu, H., Hinsdale, Ill.
Brown, Walter T., South Weymouth, Mass.
Cadenas, M. A., Habana, Cuba
Cahill, James B., Connersville, Ind.
Carroll, D. E., Hyde Park, Mass.
Cass, Fred W., Sharon, Mass.

(*ASME News continued on page 1048*)

A COMPLETE SYSTEM...

FOR INSTANT, ACCURATE CHECK ON LIQUID OR BOILER WATER LEVELS THROUGHOUT THE PLANT

Now you can have constant check-up on water levels wherever—and whenever—you want.

The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

The Yarway Indicator is always accurate because it is operated by the liquid itself. Indicating mechanism is never under pressure. There are no stuffing boxes. Complete separation of indicating and actuating parts is achieved by permanent magnet transmission.

The Automatic Control Unit is attached directly to the Indicator and operates the remote signal alarms (light or horn) at any remote locations.

The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.

YARWAY
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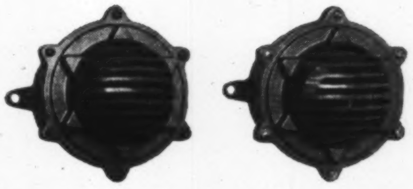
INDICATOR

Yarway Remote Liquid Level Indicator with Control Unit attached.



Yarway Remote Hi-Lo-Alarm Signal Horns.

YAR WAY
YAR WAY
YAR WAY

Three Yarway Remote Hi-Lo-Alarm Signal Lights, showing low level, normal operation and high level. Each unit shows all levels.

YARWAY REMOTE LIQUID LEVEL INDICATOR

Chaussy, Pern J., Wilmington, Del.
Condon, William F., 3rd, Watertown, Mass.
Corcoran, William H., Berkeley, Calif.
Corey, Lorin Anthony, Cleveland Heights, Ohio
Cunningham, J. Warden, Summit, N. J.
Davis, Evan A., E. Pittsburgh, Pa.
Dent, David Elmer, Culver City, Calif.
Dodds, William M., Huntington, England
Dotson, Cecil P., Dallas, Texas
Drummond, David Y., Philadelphia, Pa.
Duclos, Bernard Richard, Watertown, N. Y.
Eckhardt, David A. V., Pitman, N. J.
Eilenberger, P. F., Plainfield, N. J.
Ellis, Sydney, Jr., New Orleans, La.
Faust, Delbert G., Belleville, N. J.
Fleigler, Henry, Lawrence Park, Erie, Pa.
Flitcher, Charles L., Schenectady, N. Y.
Forsberg, Clarence Rudolph, Whittier, Calif.
Friberg, Alfred F., Portland, Ore.
Friedman, Samuel J., Wilmington, Del.
Gailey, Demosthenes W., Baltimore, Md.
Ghaswala, S. K., Bombay, India
Goat, Albert S., Bloomfield, N. J.
Golden, W. W., Youngstown, Ohio
Goll, Richard E., Philadelphia, Pa.
Gray, J. Harry, Cranston, R. I.
Guiney, Francis Michael, Floral Park, L. I., N. Y.
Hagenlocker, Ernest, Warren, Pa.
Hall, Adin Harry, Cushing, Okla.
Hall, Fred M., Los Angeles, Calif.
Harclerode, John R., Kansas City, Mo.
Heagle, William E., Ossining, N. Y.
Heaton, Robert L., Albany, Calif.
Henderson, James B., Long Beach, Calif.
Heym, Lothar S., Youngstown, Ohio
Hodge, James, Lutterworth, Rugby, England
Holbrook, Rex Rainier, Whitmore Lake, Mich.
Homrig, H. J., Clintonville, Wis.
Howe, Hedley, Stockton on Tees, Durham, England
Kaiser, Erwin J., Fond du Lac, Wis.
Kellway, Byron J., New York, N. Y.
Kenyon, Bert P., Chicago, Ill.
King, C. B., Rochester, N. Y.
King, Lyman S., San Francisco, Calif.
Latenser, James Seymour, Omaha, Nebr.
Leffmann, Warren W., Los Angeles, Calif.
Legett, John L., New Orleans, La.
MacDonald, W. R., Glen Cove., L. I., N. Y.
Mackey, Guerard, West Chester, Pa.
MacLachlan, J. M., Library, Pa.
Maneval, Glenn R., Newport, Pa.
Manson, Byrne C., Eureka, Calif.
McIntosh, W. W., Richland, Wash.
Medbery, Arnold B., Greensburg, Pa.
Mill, Victor J., Jr., Andover, Mass.
Miller, Fred A., Martinez, Calif.
Mitchell, Philip B., Memphis, Tenn.
Morgan, David E., Pennsauken, N. J.
Munder, Leo, Cleveland, Ohio
Norquist, William B., Seattle, Wash.
Orenbuch, Louis L., Washington, D. C.
Patchen, Lee Harold, Spokane, Wash.
Pilcher, J. M., Columbus, Ohio
Piper, John R., Albuquerque, N. Mex.
Podolny, William H., Manchester, Conn.
Pomrening, Marlow H., Chicago, Ill.
Pope, George, Dallas, Texas
Prior, G. Graham, Columbus, Ohio
Raine, George, Montreal, Que., Can.
Ramseyer, Frank J., San Gabriel, Calif.
Ratzel, Arthur C., Brooklyn, N. Y.
Reed, C. Lawson, Jr., Cincinnati, Ohio
Reggiardo, Louis J., Maywood, Calif.
Reitz, Clifford J., Bridgeport, Conn.
Ronan, John T., Jr., Berkeley, Calif.
Ross, Edward D., Los Angeles, Calif.
Rowbotham, G. E., Cleveland, Ohio
Scott, George E., Minneapolis, Minn.
Sharp, Robert A., Wauwatosa, Wis.
Shepherd, D. G., Ithaca, N. Y.
Simpson, Thomas Francis, Los Angeles, Calif.
Sloan, James W., Birmingham, Ala.
Slusser, Harry R., Canton, Ohio
Smith, Sharon LaMarr, Topeka, Kan.
Spencer, Joseph R., Philadelphia, Pa.
Staples, G. McLellan, 3rd, Louisville, Ky.
Stewart, James E., Moline, Ill.
Stewart, Robert Morris, Knoxville, Tenn.
Stiansen, Stanley G., Bay Shore, N. Y.
Stickler, Lee E., Springfield, Ill.
Strohl, Stanley M., Indianapolis, Ind.
Strom, Gordon H., New York, N. Y.
Swager, Vladimir W., Brno, Svitavska 5, Czechoslovakia
Taylor, Elliot L., Dover, N. J.
Thomas, Ralph H., Rahway, N. J.
Townsend, John R., Murray Hill, N. J.
Vogel, Dan H., Columbus, Ohio
Wadsworth, G. E., Bridgeport, Conn.
Ward, Edwin Grant, Crawfordsville, Ind.
Ware, William H., Jr., Los Angeles, Calif.
White, Warren H., Ruston, La.
Williams, Berkeley, Jr., Williston Park, N. Y
Williamson, James D., Dayton, Ohio
Winn, Richard B., Charleston, W. Va.
Yavitz, Boris, New York, N. Y.

Transfer to Member

Balthrop, Edward S., Jr., Staunton, Va.
Beck, Joseph H., New York, N. Y.
Boyajian, Richard Deran, Philadelphia, Pa.
Bridges, Robert M., No. Hollywood, Calif.
Bursack, William W., Richfield, Minn.
Drum, Leo J., Jr., Montgomery, Ala.
Elder, L. C., Hamilton, Ont., Can.
Gathman, David W., Williamsport, Pa.
Giordano, Joseph, Philadelphia, Pa.
Goland, Martin, Kansas City, Mo.
Guenther, E. G., Kingsport, Tenn.
Guldenbecker, Albert, Chicago, Ill.
Haglund, G. O., Buffalo, N. Y.
Holcombe, Marshall M., New York, N. Y.
Hudson, Donald E., Pasadena, Calif.
Janicek, Joseph J., Chicago, Ill.
Kearns, J. E., St. Paul L'Ermite, Que., Can.
Kenworthy, J. M., Ardmore, Pa.
Leggett, James T., Gainesville, Fla.
Mabie, Hamilton H., Ithaca, N. Y.
Morain, Wilfred A., Hamilton, Ohio
Mundel, Marvin E., Lafayette, Ind.
Myers, Phillip S., Madison, Wis.
Norcross, Gilbert F., West Caldwell, N. J.
Parr, Jerome H., Dayton, Ohio
Pegram, William B., Swarthmore, Pa.
Prohl, Melvin A., Melrose, Mass.
Reisman, Howard H., Rock Island, Ill.
Schiller, Frank M., Queens, L. I., N. Y.
Sharp, J. Cecil, Logan, Utah
Shriver, W. B., Dallas, Texas
Stark, Albert C., Morton, Pa.
Updike, Ronald W., Indianapolis, Ind.
West, Woodrow W., Rosemont, Pa.
Witt, Ted R., Kingsport, Tenn.

Transfers from Student Member to Junior.....109

Obituaries

Charles W. Bray (1864–1948)

Charles W. Bray, former pres. of the American Sheet and Tin Plate Co., Pittsburgh, Pa.; died, Haverford, Pa., Jan. 22, 1948. Born, Pittsburgh, Pa., Feb. 14, 1864. Parents, Thomas J. and Anna J. (Collins) Bray. Educated, public schools, Pittsburgh, Pa. Mem. ASME, 1888. Married May Harris, Nov. 19, 1892; one son, William McKinley Bray.

Howard Butt (1888–1948)

Howard Butt, vice-pres., William Powell Co., Cincinnati, Ohio; general manager, New York branch; died Aug. 23, 1948, Brielle, N. J. Born, April 9, 1888, Sandusky, Ohio. Parents, Richard L. and Mary E. (Jordan) Butt. Education, Marion Military Institute; Polytechnic Institute of Alabama; CE degree, 1908. Mem. ASME, 1923. Survived by wife, Sally Ware Butt, and two brothers, Richard L. and Arthur J. Butt.

Frederic Munroe Card (1870–1948)

Frederic M. Card, head, testing laboratory, Singer Manufacturing Co.; died, March 21, 1948. Born, Candor, N. Y., March 2, 1870. Parents, Alonzo and Harriet (Munroe) Card. Educated, public schools, Bridgeport, Conn. Mem. ASME, 1906. Survived by wife, Lillian Courtwright Card, and two daughters, Mrs. Royal P. Schiff and Mrs. Wallace Lee.

Axel Folke Carlson (1892–1948)

Axel F. Carlson, manager, Aktiebolaget A. C. Gustafson, Stockholm, Sweden, died March 14, 1948. Born, Atvidaberg, Sweden, March 25, 1892. Parents, Carl Gustav and Mildred Wilhelmina Carlson. Education, Stockholm Tekniska Skola; ME, Katrineholms Tekniska Skola, 1918. Naturalized, Boston, Mass., Jan. 21, 1929. Mem. ASME, 1932.

Arthur Williams Cole (1875–1948)

Arthur W. Cole, retired professor of steam engineering, Purdue University, Lafayette, Ind.; died Feb. 9, 1948, Orleans, Mass. Born, Worcester, Mass., Feb. 17, 1875. Parents, Alonzo W. and Ellen L. (Berry) Cole. Education, BS Worcester Polytechnic Institute, 1902, ME, 1907. Jun. ASME, 1904, Mem. ASME, 1911. Survived by wife, Emma L. Taylor Cole, and son, Robert Williams Cole.

Earle Morse Copp (1884–1948)

Earle M. Copp, executive sugar engineer, Graver Tank and Mfg. Co., Inc., New York, N. Y., died, Bronxville, N. Y., Feb. 9, 1948. Born, Albion, N. Y., March 17, 1884. Parents, Andrew Newton and Alice Florence (Jewell) Copp. Education, BS, Louisiana State University, 1909. Mem. ASME, 1928. Survived by wife, Mittie Tarver Copp, and two sons, Albert Lummus and Earle M. Copp, Jr.

Alexander Jack Dickie (1876–1948)

Alexander J. Dickie, retired editor, *Pacific Marine Review*, and technical journalist, died Aug. 17, 1948. Born, San Francisco, Sept. 30, 1876. Parents, George William and Anna (Jack) Dickie. Education, St. Matthews Academy, San Mateo, Calif.; BS, University of California, 1897. Mem. ASME, 1919; Fellow ASME, 1936. Former chairman, San Fran-

(*ASME News continued on page 1050*)

The first Rotary Positive Blower built by anyone was produced in the "Roots" plant in 1854—six years before the first pony express. We're not good because we're old, we're old because we're good!

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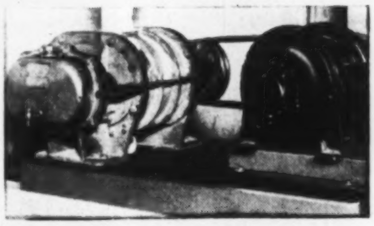
90 YEARS TOO SOON



R-C Rotary Positive Blower built into modern gas-oven equipment to maintain constant, correct gas flow for even baking temperatures.

When she made those mouth-watering cookies, Grandma didn't have perfect baking temperatures, obtained from an even flow of gas. Even though "Roots" equipment was available almost 100 years ago, neither home nor commercial bakers had learned how to apply it to making cookies.

Now, it's different. Roots-Connersville Rotary Positive or Centrifugal Gas Pumps and Boosters help regulate gas and air supplies for every industry, where reliable performance is essential for profitable operations.

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BLOWER BUILDERS R-C SINCE 1854
BLOWERS · EXHAUSTERS · BOOSTERS · LIQUID AND VACUUM PUMPS · METERS · INERT GAS GENERATORS

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R-C Centrifugal Boosters insure deliveries of gas in sufficient quantities, at the right pressures for home, commercial and industrial users.

cisco Section; manager Society 1931–1934; advisory member Publications Committee; ASME representative on Joint Committee for Accrediting Engineering Curricula. Survived by wife, Clara Gertrude Paulin Dickie, and two sons, Arthur W. and Gordon Dickie.

Frank W. Fox (1882–1948)

Frank W. Fox, chairman, Fuel Economy Committee, Technical Service Division, Standard Oil Co. of N. J., died Aug. 5, 1948. Born, Chester, Pa., Nov. 2, 1882. Education, Bayonne High School, N. J., 1900. Assoc. ASME, 1919; Mem. ASME, 1935.

Lawford Howard Fry (1873–1948)

Lawford H. Fry, director of research, Steam Locomotive Institute, Inc., New York, N. Y.; died July 12, 1948, Mount Vernon, N. Y. Born, Richmond, Quebec, Can., June 16, 1873. Parents, Howard and Elizabeth Tyrell (Lawford) Fry. Education, City and Guilds Institute, London, England; University of Göttingen, Germany; Hannoversche Technische Hochschule, Hanover, Germany. Married Marjorie Stockton, Sept. 9, 1905 (died Sept., 1932); children, Frances Elizabeth, Lucy Howard, Alison Marjorie (Mrs. Nelson Orr Wieman), Humphrey Lawford, and Christopher Arthur. Married 2d, Mildred Lucinda Kolb, Dec. 2, 1935. Awards, 1928, T. Bernard Hall prize, The Institution of Mechanical Engineers; 1938, ASME Worcester Reed Warner Medal. Mem. ASME, 1905; Fellow, ASME 1942. Survived by wife, five children and a brother, Lindsay B. Fry.

Selby Haar (1881–1948)

Selby Haar, electrical engineer, Board of Transportation, City of New York, died Sept. 5, 1948, in New York, N. Y., due to effects of a brain-tumor operation; also arteriosclerosis. Born, Kansas City, Mo., Nov. 24, 1881. Parents, Julien and Laura (Sonshine) Haar. Education, Central High School, Kansas City, Mo.; BS, Massachusetts Institute of Technology, 1904. Mem. ASME, 1912; first secretary, Railroad Division; secretary, Standing Comm. on Professional Division; mem. Standardizing Comm. on Elevators.

Aldus Chapin Higgins (1872–1948)

Aldus C. Higgins, chairman, executive committee, Norton Company, Worcester, Mass., died Sept. 10, 1948, Worcester, Mass. Born, Dec. 7, 1872, Worcester, Mass. Parents, Milton Prince and Katherine Elizabeth (Chapin) Higgins. Education, BS Worcester Polytechnic Institute, 1893; LLM National University Law School, 1896. Married Edgenie G. Brosius, 1898 (died 1911); children, Elizabeth B. (Mrs. Ernest Angell) and Milton Prince Higgins. Married 2d, Mary Sprague Green, Jan. 16, 1914. Honors, D.Eng. Worcester Polytechnic Institute, 1931. 1947, Royal Swedish Order of Vasa, first class, rank of chevalier. Awards, John Scott Medal, 1913, by The Franklin Institute. Mem. ASME, 1916. Survived by wife, two children, and brother, John Woodman Higgins, and sister, Mrs. Lewis I. Prouty.

Alfred Holter (1884–1948)

Alfred Holter, managing director, Dalen Portland Cement Works, Brevik, Norway, died July 17, 1948, subsequent to injuries sustained in an explosion aboard his yacht in Norway. Born, Oslo, Norway, May 19, 1884. Parents, Anders and Marie (Schmidt) Holter. Education, Norwegian Military Academy, 1903; Cand. Ingenieur ME, Institute of Hanover, 1906; Diplom Ingenieur, Naval Architecture, Institute of Danzig, 1908. Honors, Knight of St. Olav (Norwegian); Knight of Dannebrog (Danish). Mem. ASME, 1945. Survived by a daughter, Mrs. Erwin A. Jonas of New York, N. Y.

Christian B. Ketcham (1890–1948)

Christian B. Ketcham, branch manager, Cincinnati (Ohio) Central District, Westinghouse Elec. and Mfg. Co., died on July 6, 1948, at his desk while conducting the business of the day. Born, Marshall, Texas, June 3, 1890. Parents, Christian Brower and Louise (Menger) Ketcham. Education, BSEE, Alabama Polytechnic Institute, 1911. Married, Martha Hein, Aug. 18, 1917. Mem. ASME, 1943. He is survived by his wife and a daughter, Carolyn.

Carl W. Littler (1880–1947)

Carl W. Littler, retired chief engineer, Jones and Laughlin Steel Corp., Pittsburgh, Pa., died Nov. 11, 1947, at his home in Pittsburgh, Pa., of heart failure. Born, Winterthur, Switzerland, Dec. 11, 1880. Parents, John and Emilie Littler. Education, ME, University of Zurich, 1902. Naturalized, Pittsburgh, Pa., 1911. Married, Dr. Margaret L. Lanzetta, 1934, who survives him. Mem. ASME, 1925.

Carl Haessler Marquit (1920–1948)

Carl H. Marquit, mechanical engineer, died August 1, 1948. Born, Brooklyn, N. Y. Sept. 14, 1920. Education, BME, CCNY 1940. Jun. ASME, 1940.

Robert Duane Myers (1885–1948)

Robert D. Myers, power engineer, during World War II attached to 67th Naval Constr. Bn., died August 28, 1948. Born, Waynesboro, Pa., Dec. 11, 1885. Education, Juniata College, 2 years; ME certificate ICS. Assoc. ASME, 1921; Mem. ASME, 1929.

Keith Franklin Pumphrey (1919–1948)

Keith F. Pumphrey, welding engineer, Big Three Welding Equipment Co., Fort Worth, Texas, died June 21, 1948. Born, Fort Worth, Texas, July 23, 1919. Education, BSME, Texas A. and M. College, 1945. Jun. ASME, 1945.

Theodore Reunert (1856—date not known)

The Society was recently advised that Dr. Theodore Reunert, chairman, Reunert and Lenz, Ltd., Johannesburg, South Africa, died several years ago. Born, Leeds, Yorkshire, England, July 13, 1856. Education: Real Gymnasium, Cassel, Germany; Yorkshire College, Leeds, England. Honors, 1922, Yorkshire College of Science (now Leeds University), Litt. D. Mem. ASME, 1901.

Joseph Seaman (1878–1948)

Joseph Seaman, owner, Saw Shop, died Aug. 20, 1948, Jackson, Mich. Born, Nassau County, N. Y., March 7, 1878. Parents, Charles Post and Mary (Meyers) Seaman. Education, public school. Married, Emma W. Loeser, 1904; children, William and Joseph. Jun. ASME, 1928; Mem., ASME 1935. Survived by wife, two sons, sister, Anne Seaman, brother, Charles Seaman, and four granddaughters.

Alfred E. M. Shafer (1898–1948)

Alfred E. M. Shafer, research engineer, Pennsylvania Power and Light Co., died April 5, 1948, Allentown, Pa. Born, Lehighton, Pa., Jan. 26, 1898. Parents, Alfred and Emma (Straup) Shafer. Education, Lehighton High School, Perkiomen School, ME Lehigh University, 1920. Married Miriam A. Hammerly; children, Barbara Ann, Mary Jane, and Nancy Lou. Mem. ASME, 1947. Survived by wife and three daughters; four sisters, Mabel, Florence, Ester Shafer, and Mrs. George Graef.

Benjamin Crosby Sloat (1877–1948)

Benjamin C. Sloat, consulting engineer, died July 21, 1948, New York, N. Y. Born, Patterson, N. Y., Oct. 12, 1877. Parents, Orson Wright and Sarah Louise (Penny) Sloat. Education: Brooklyn Polytechnic Institute; ME, Cornell University, 1902. Married, Helen Louise Leavenworth, June 26, 1915. Assoc. ASME, 1918; Mem. ASME, 1923. Survived by nephew, John C. Sloat, Patterson, N. Y., and niece, Mrs. Evelyn Ellson, Philadelphia, Pa.

Thomas Bliss Stillman (1890–1948)

Thomas Bliss Stillman, engineering consultant, Babcock and Wilcox Co., New York, N. Y., died Sept. 28, 1948, Philadelphia, Pa. Born, Hoboken, N. J., June 12, 1890. Parents, Thomas Bliss and Emma Louise (Pomplitz) Stillman. Education, Stevens Preparatory School; ME Stevens Institute, 1912. Married Harriet T. McCormick, 1916 (died, 1946). Jun. ASME, 1913; Assoc. ASME, 1921; Mem. ASME, 1946. Survived by second wife, former Eloise Brown Keenan; a sister, Mrs. E. A. Quarles, and a brother, Albert L. Stillman.

David Montgomery Updike (1881–1948)

David M. Updike, consultant in combustion engineering, died July 24, 1948, New York, N. Y. Born, Jersey City, N. J., Aug. 9, 1881. Parents, David Schenek and Fannie (Montgomery) Updike. Education; Trinity School, N. Y.; ME, Columbia University, 1906. Married, Adeline Leonard. Children. Marjorie, Theodora, and David M., Jr. Mem. ASME, 1920. Survived by wife and three children; four brothers, Harold W., Godfrey E., G. Campbell, and Stuart N., and a sister, Dorothy Updike Green.

Edward Malcolm Whiting (1890–1948)

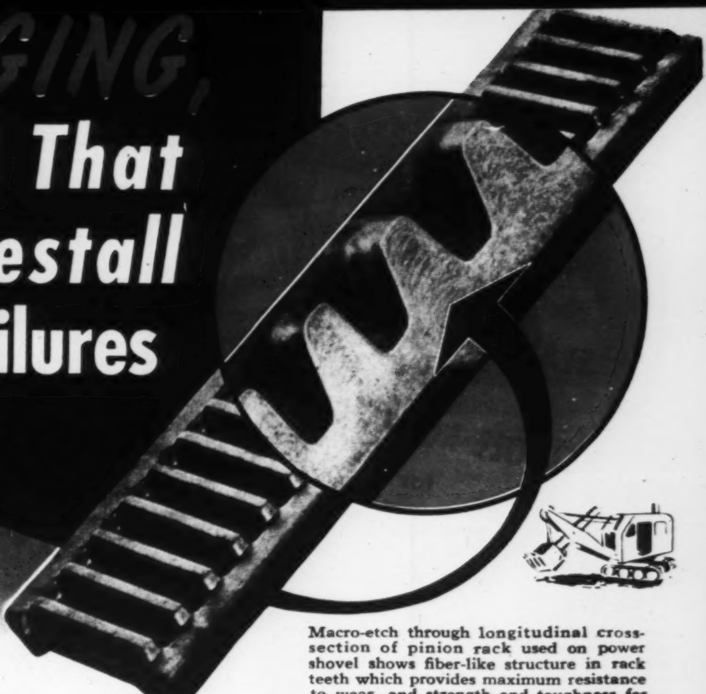
Edward M. Whiting, pres., Pheoll Mfg. Co., Chicago, Ill., died July, 1948. Born, Detroit, Mich., April 30, 1890. Parents, Edward A. and Josephine R. (Prevost) Whiting. Education, Western High School, Detroit, Mich. Married, Estelle S. Trader, June 24, 1911. Son, Clayton E. Assoc. ASME, 1928; Mem. ASME, 1935.

Necrology

The deaths of the following members have recently been reported to headquarters:

Becker, Julius, August 25, 1948
Bonine, Charles E., October 26, 1948
Hobbs, Elmer E., October 10, 1948
Hutchinson, Robert C., date not known
Pettibone, Charles E., October 10, 1948
Trowbridge, Francis C., September 11, 1948
Von Voigtlander, Oscar, October 4, 1948
Walker, Sidney G., date not known.

When You Use a FORGING, You Have Done All That Can Be Done to Forestall Unpredictable Parts Failures



Macro-etch through longitudinal cross-section of pinion rack used on power shovel shows fiber-like structure in rack teeth which provides maximum resistance to wear, and strength and toughness for shocks and stresses occurring continually when in use. This fiber-like structure is common in all high quality forgings.

THERE IS NO SUBSTITUTE for the strength and toughness inherent in the forged fiber-like flow-line structure of forgings. The forging method of fabricating parts in closed impression dies directs, controls and concentrates the fiber-like flow-line structure of metals at points of greatest shock and stress. In forgings you obtain the strength and toughness for unrelenting and uninterrupted performance. When you use a forging, you have done all that can be done to forestall the failure of parts and to protect the user of your equipment from unpredictable emergencies. Forgings provide rapid assembly of complex parts as by welding; forgings permit reduction of dead weight because maximum strength and toughness are obtainable in lighter sectional thicknesses. The metal quality and cost-reducing advantages obtainable in forgings cannot be equalled or duplicated. Recheck every stressed part in your equipment, and consult a forging engineer about possibilities for reducing costs of machining and finishing, speeding up assembly and improving performance. Only a forging engineer can inform you fully regarding the many advantages of forgings.

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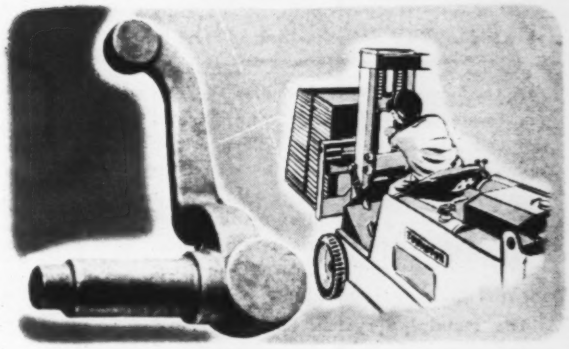
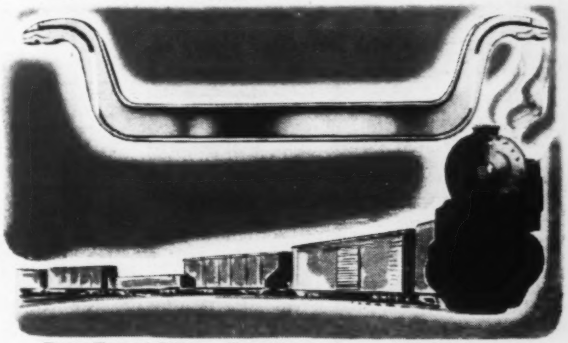


The steering mechanism of Towmotor lift trucks must operate smoothly at all times and under all kinds of loading without failure. To insure such trouble-free performance, the engineer designed this steering knuckle to be a forging, thereby obtaining a greater factor of safety which is so essential in materials handling equipment.



Drop Forged I-Beam Equalizer weighing 405 lbs. replaces an 800 lb. unit on freight cars. This illustrates how forgings reduce dead weight, yet provide a greater factor of safety that is so important in railroad operation. This drop forged I-Beam requires less machining and processing, and scrap loss is almost totally reduced because forgings are unusually free of concealed defects.

DROP FORGING ASSOCIATION

METAL QUALITY
HOT WORKING IMPROVES PROPERTIES OF METAL
TOPICS

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☐ Booklet on "Metal Quality—Hot Working Improves Properties of Metal."

☐ "Drop Forging Topics" which presents numerous end use applications of forgings.

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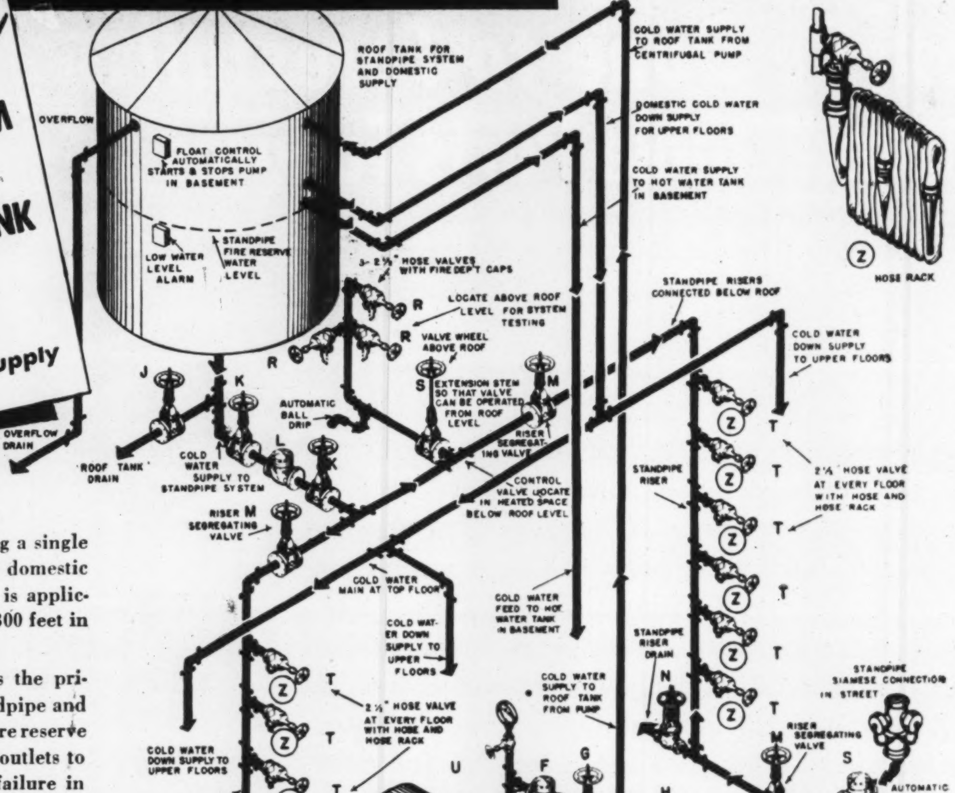
Company ....

Address .... *City* .... *State* ....

Jenkins PRACTICAL PIPING LAYOUTS 38

How to plan a STANDPIPE SYSTEM with SINGLE ROOF TANK for Fire Line and Domestic Water Supply

Diagram by Huxley Madeheim
Consulting Engineer


ROOF TANK FOR STANDPIPE SYSTEM AND DOMESTIC SUPPLY
OVERFLOW
FLOAT CONTROL AUTOMATICALLY STARTS & STOPS PUMP IN BASEMENT
LOW WATER LEVEL ALARM
STANDPIPE FIRE RESERVE WATER LEVEL
3- 2½" HOSE VALVES WITH FIRE DEP'T CAPS
LOCATE ABOVE ROOF LEVEL FOR SYSTEM TESTING
VALVE WHEEL ABOVE ROOF
EXTENSION STEM SO THAT VALVE CAN BE OPERATED FROM ROOF LEVEL
RISER SEGREGATING VALVE
CONTROL VALVE LOCATE IN HEATED SPACE BELOW ROOF LEVEL
AUTOMATIC BALL DRIP
OVERFLOW DRAIN
ROOF TANK DRAIN
COLD WATER SUPPLY TO STANDPIPE SYSTEM
RISER SEGREGATING VALVE
COLD WATER MAIN AT TOP FLOOR
COLD WATER DOWN SUPPLY TO UPPER FLOORS
COLD WATER FEED TO HOT WATER TANK IN BASEMENT
COLD WATER SUPPLY TO ROOF TANK FROM CENTRIFUGAL PUMP
DOMESTIC COLD WATER DOWN SUPPLY FOR UPPER FLOORS
COLD WATER SUPPLY TO HOT WATER TANK IN BASEMENT
HOSE RACK
STANDPIPE RISERS CONNECTED BELOW ROOF
COLD WATER DOWN SUPPLY TO UPPER FLOORS
STANDPIPE RISER
2½" HOSE VALVE AT EVERY FLOOR WITH HOSE AND HOSE RACK
STANDPIPE RISER DRAIN
STANDPIPE SIAMESE CONNECTION IN STREET
COLD WATER SUPPLY TO ROOF TANK FROM PUMP
COLD WATER DOWN SUPPLY TO UPPER FLOORS
STANDPIPE RISER
2½" HOSE VALVE AT EVERY FLOOR WITH HOSE AND HOSE RACK
STANDPIPE RISER DRAIN
CENTRIFUGAL PUMP TO SUPPLY ROOF TANK
CONTROLLED BY ROOF TANK FLOAT CONTROL
DRAIN
AUTOMATIC BALL DRIP
WATER SUPPLY FROM STREET MAINS
WATER METER
METER TEST CONNECTION
RISER SEGREGATING VALVE
STANDPIPE RISERS CONNECTED IN BASEMENT
COLD WATER SUPPLY TO LOWER FLOORS WHERE STREET PRESSURE IS SUFFICIENT
A
B
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K
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U
Z

A typical standpipe system using a single roof tank for both fire line and domestic water supply is shown here. It is applicable to buildings not exceeding 300 feet in height.

A roof gravity tank provides the primary water supply for both standpipe and domestic supply. The standpipe fire reserve is below the hot and cold water outlets to assure water supply in case of failure in the main line. The float controlled roof tank is supplied from a centrifugal pump in the basement, or directly from the street main if pressure is sufficient.

The standpipe system has two risers, cross connected at the top and bottom of the system. This allows one riser to be shut down for repairs while the other one remains in service. The bottom connection is tied into the siamese street connection for attachment to fire department pumps.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation. Copies of Layout No. 38, enlarged, with additional information, will be sent on request. Just mail the coupon.

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To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the Jenkins Catalog. It's your best assurance of *lowest cost in the long run.*

VALVE RECOMMENDATIONS

For details and valves to suit varying conditions see Jenkins Catalog.

Code	Quan.	Jenkins Valves	Service
A	2	•Fig. 825 I.B.B.M. Gate	Main Water Supply Shutoffs
B	1	•Fig. 629 I.B.B.M. Swing Check	Prevent Backflow to Mains
C	1	Fig. 106-A Bronze Globe	Water Meter Test Valve
D	2	•Fig. 825 I.B.B.M. Gate	Cold Water Supply Shutoff
E	1	•Fig. 629 I.B.B.M. Swing Check	Prevent Backflow from Pump
F	1	•Fig. 629 I.B.B.M. Swing Check	Prevent Backflow to Pump

Code	Quan.	Jenkins Valves	Service
G	1	•Fig. 825 I.B.B.M. Gate	Centrifugal Pump Discharge
H	1	Fig. 275-U Bronze Gate	Pump & Riser Drain
J	1	Fig. 651 I.B.B.M. Gate	Roof Tank Drain
K	2	Fig. 825 I B.B.M. Gate	Roof Tank Shutoff
L	1	Fig. 629 I.B.B.M. Swing Check	Prevent Backflow to Roof Tank
M	4	Fig. 825 I.B.B.M. Gate	Standpipe Riser Segregation
N	2	Fig. 275-U Bronze Gate	Riser Drains
P	1	Fig. 825 I.B.B.M. Gate	Control Valve for Roof Test Hose Valves
R	3	Fig. 715-A Bronze Angle Hose	Roof Test Manifold
S	1	Fig. 629 I.B.B.M. Swing Check	Prevent Standpipe Water Draining thru Siamese
T	12	Fig. 715-A Bronze Angle Hose	Hose Shutoffs
U	2	Fig. 741-G Bronze Needle	Pressure Gage Control

•All Bronze Valves optionul

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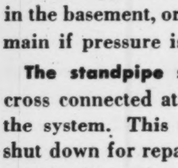

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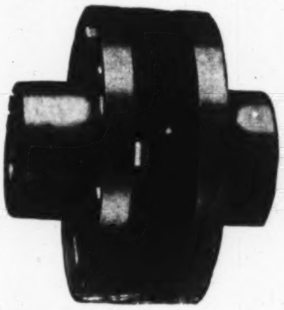
Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• *NEW EQUIPMENT*

Lord Multiple H. P. Couplings

The Lord Manufacturing Co. of Erie, Pa. announces a new line of Multiple H.P. Couplings from 2 to 100 h.p. at 1750 r.p.m.

The complete line is now available in 17 sizes from $^{1}/_{50}$ to 100 h.p. at 1750 r.p.m.



$^{1}/_{50}$ to 15 h.p. couplings have 15° torsional deflection under rated load. Sizes 30 to 100 h.p. have 3°. It is claimed that this high deflection gives unusual vibration isolation. Couplings will accommodate at least 2° angular and $^{1}/_{32}$" parallel misalignment.

Neoprene flexing elements operate in shear and are bonded to steel plates. Since there are no bearing surfaces to chafe, couplings are permanently quiet, they require no lubrication and they are unaffected by such abrasives as emery, sand, crushed rock or metal particles.

For complete information write Lord Manufacturing Co., Erie, Pa., and ask for Bulletin 201.

New Industri-Jet Pumps

Goulds Pumps, Inc. of Seneca Falls, N. Y., has announced a new line of high pressure, low capacity pumps for industry. Called the "Industri-Jet," this pump is a combined centrifugal and jet or ejector type pump in one compact unit.

GOULDS
PUMPS

The "Industri-Jet" Pumps cover a range up to 190 lbs. pressure with capacities up to 35 G.P.M. and are designed for handling cold or hot water, alcohol, kerosene, carbon tetrachloride and similar liquids. The Industri-Jet can be used for general water supply, condensation return, spraying, filter press service, booster service—in practically any pumping problem that requires high pressure with low capacity.

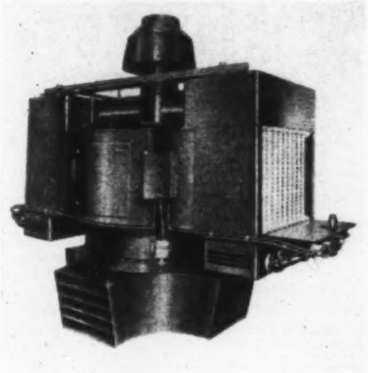
The Industri-Jet has certain advantages over conventional pumps in its class. For example, it is self-priming and cannot vapor lock. It handles both wet and dry liquids. There are no close running fits or clearances and the only moving part is the rotating impeller and shaft.

The Industri-Jet is built for continuous service and requires little maintenance attention. The mechanical seal is self-adjusting for wear and requires no lubrication.

For complete information about this new pump, write Goulds Pumps, Inc., Seneca Falls, N. Y., and ask for Bulletin 630-A1.

Wing Introduces Gas-Fired Unit Heater

A new, self-contained gas-fired revolving unit heater has been announced by the L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y., originators of the revolving unit heater. Using either natural or manufactured gas, the heater combines gas burners, heat exchanger and combustion chamber with a motor-driven Wingfoil fan and Wing revolving discharge outlets.



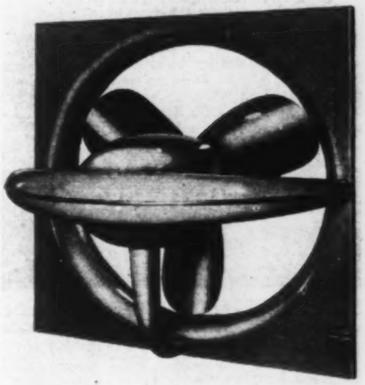
Designed for overhead location, it projects the heated air to the working level and by means of the revolving outlets circulates the warmth in all directions, under obstacles, into pits, and reaches into the farthermost corners.

Even in the summer these heaters are at work, but here they become a cooling device by simply turning off the gas and turning the fans on. The air is circulated in the same manner as the heated air in the winter, creating a pleasing sensation of relief from oppressive stifling heat.

The Wing Gas-Fired Revolving Unit Heater is a ruggedly constructed piece of equipment. Heat exchanger and combustion chamber of grey iron are cast together in one piece. No gaskets are required, nothing to burn out or to disintegrate. Extended heating surface fins on the heat exchanger are cast integral, nothing to move, or loosen. Burners are constructed of grey iron with drilled ports. Each tube of the heat exchanger has a separate burner head which permits the flame to burn in the tubes without impingement on the metal.

The Wing Gas-Fired Revolving Unit Heater is approved by the American Gas Association. Descriptive bulletin may be obtained from the manufacturer.

New Ventura Propeller Fan



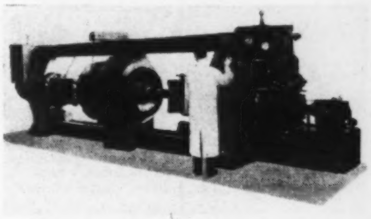
Designed to combine distinctive styling with exceptional economy, a new Model A Ventura Propeller Fan, for exhausting bad air, fumes and odors, has been added to the complete line of American Blower industrial, commercial and home ventilating equipment.

Many refinements in design and construction have been incorporated in the new fan and its advanced styling blends ideally with modern interiors.

Important advantages include: square mounting panel, easily installed; streamflow motor enclosure; smooth easy-to-clean surfaces; terminal box without exposed wiring; Aerocurve 3-blade propeller; streamlined inlet for substantial savings in power.

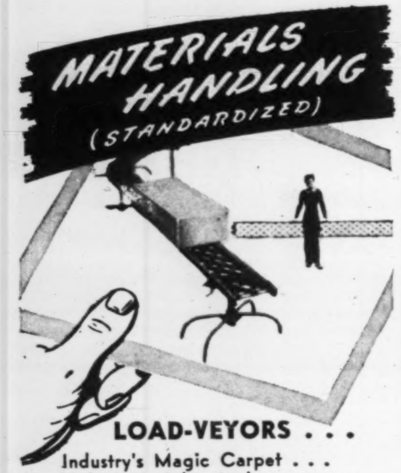
All units are rated for sound. Air deliveries are in accordance with Standard Test Code adopted jointly by the NAFM and ASH&VE.

New Press Handles All Wheel Sets Faster



A new production de-mounting press, said to be the fastest to date, and capable of handling all types of wheel sets without the use of spacers, has been developed by the Watson-Stillman Co., Roselle, N. J. The new double-end machines, with 54" clearance

Continued on Page 42



LOAD-VEYORS . . .

Industry's Magic Carpet . . .
Lightest weight steel conveyor.
Reversible — use either side.
Removable connectors.
Easily stored.
Stands may be placed at any point.
One man can carry two 10 ft. sections.
Full selection of sections.

Write for bulletins:
1001 Casters · 1002 Running gear · 1003 Floor trucks · 1004 Conveyor · 1005 Lift trucks · 1006 Skids · 1007 Semi skids and jacks · 1009 Special trucks, etc. · 1101 Electric Lift truck.

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30 Garvey St., Everett 49, Mass.

Polaroid* . . .
Photoelastic Polariscope
for Stress Determination

For either qualitative or quantitative photo-elastic analysis, perfection in the projection lens system is of major importance.

In our new model polariscope of 4¼″ clear aperture, the parallel beam is collected by a rear element and condensed through a three component lens of the Cooke system. In the new larger unit (8¼″ aperture) a four component lens of the Omnar system is used. *The image is sharp throughout the field, free of aberration, astigmatism, and distortion.*

Literature of new model polariscope now available

POLARIZING INSTRUMENT CO., Inc.
Mount Kisco, N. Y.

**T.M. Reg. U. S. Pat. Off. Polaroid Corporation*

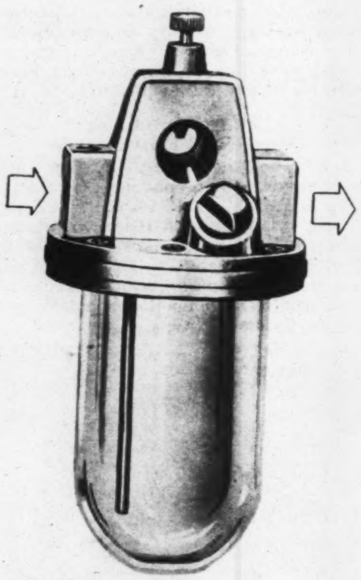
between bars and a stroke at each end of 26″, are available in 400 and 600 ton sizes. It is claimed that these specifications are adequate to de-mount all freight, passenger, locomotive tender and truck wheels at a set-a-minute rate.

An unusual advantage attributed to the machine is its ability to de-mount diesel wheels on a production basis without disturbing the drive gear. A special beam can also be provided, as an extra, to remove passenger car wheels without pressure being brought to bear on the Spicer drive.

Single station push-button controls initiate all movements of the press. Rapid traverse is provided for all idle portions of stroke. Positive overstroke protection is designed to prevent cocking of rams in service.

The press can also be used for mounting car wheels and axle assemblies, and all the gages and recording instruments necessary for this purpose are included as part of the standard equipment.

New Automatic Air Line Lubricator Announced by Hannifin

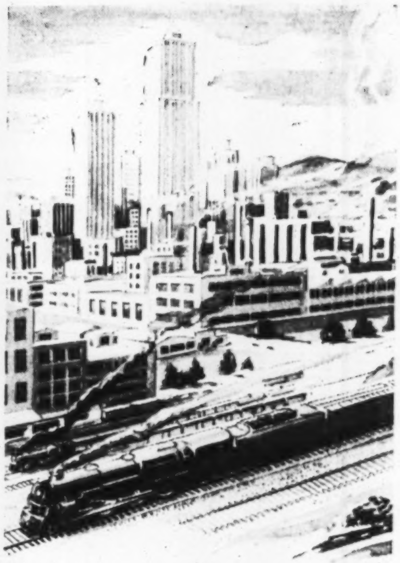


Development of a new automatic lubricator for installation on lines serving compressed air operated tools and equipment is announced by Hannifin Corp., Chicago maker of pneumatic and hydraulic machinery. The lubricator meters the oil into the air stream as a fine mist, which is beneficial in reducing friction and heat and also greatly prolongs the life of air powered equipment.

Of sturdy construction and attractively styled, the lubricator consists essentially of a body to which pipe connections are made and a bowl containing a supply of lubricating oil. The rate of flow of oil is visible from both sides and can be accurately controlled by a needle valve.

The bowl is of transparent plastic construction, thus the oil level is visible at all times. Removal of an oil filler plug in the body automatically shuts off the supply and releases air pressure in the bowl, making it possible to replenish oil without shutting off line pressure. High economy in oil consumption is attained due to the fact that oil is injected only when air is flowing.

Designated as the Hannifin Series "RL" Automatic Air Line Lubricator, units are now available in $^3/_8''$ and $^1/_2''$ sizes built of non-



Higher Production
LOWER OPERATING COST

TWO outstanding features of Layne Well Water Systems are—Higher Production and Lower Operating Cost. These advantages are the result of excellence in engineering design, plus the proper methods of installation. Such features are of utmost importance in all situations where ground water is used in large quantities: cities, factories, chemical plants, railroads, packing houses, steel mills, refineries, etc.

But Layne is not satisfied to offer higher production and lower operating cost alone. There is the matter of dependable quality and substantial construction. Not once in nearly seventy years of Layne operation has quality been lowered. Today, your Layne Well Water System is better than ever before; tougher where wear is heaviest, more rugged where strength is needed and finer machined for accuracy and smoother operation.

For the best that skill and care can create, plus top flight and proved efficiency at low operation cost, insist on a Layne Well Water System.

For further information, catalogs, bulletins, etc., address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

LAYNE
WELL WATER SYSTEMS

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne Central Co. Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Minnesota Co., Minneapolis, Minn. ★ Iternational Water Corporation, Pittsburgh, Pa. ★ International Water Supply, Ltd., London, Ont., Can. ★ Layne-Hispano Americana, S. A., Mexico, D. F.

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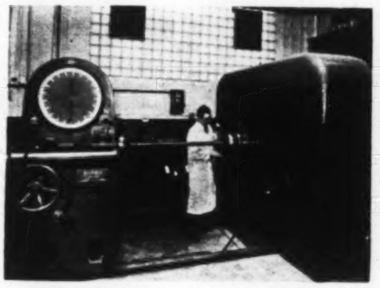
corrosive materials for line pressures to 150 p.s.i. Moderate cost makes it practical to install an individual lubricator on each piece of compressed air operated equipment used, preferably close to the equipment served.

Operation of the lubricator is simple and foolproof, never requiring any attention other than to fill bowl with approximately 1/2 pint of oil. Descriptive literature and information can be obtained by writing to Hannifin Corp., 1101 South Kilbourn Ave., Chicago 24, Illinois.

New Type of Torsion Machine

The first of a new type of torsion machine developed by Baldwin Locomotive Works has been installed by Mack Trucks, Incorporated, in its research laboratory at Plainfield, N. J. It is being used there to test axle shafts, crankshafts, frame and body members of buses and trucks that are subjected to torsional stresses in service. Mack engineers will use these tests to select steels and alloys for these parts, to determine the best heat treatments, and in general to guide design of truck and bus parts.



In some torsion tests local stresses in crankshafts, body and frame members will be indicated and measured by means of Stresscoat and SR-4* bonded resistance wire strain gages, particularly in fillets and any other points where excessive stress concentration must be prevented. A recorder which will produce curves of torque versus angle of twist will be mounted on the indicator cabinet for many tests. In general the machine will be used to develop basic information for the use of designers of truck and bus parts. It will also be used to calibrate an adjoining torsional fatigue machine before starting fatigue tests.

The Mack torsion machine has a maximum capacity of 1,000,000 inch pounds, and is large enough to test bars or tubes up to 10 feet long and 6 inches in diameter. It consists of a rigid base frame, a drive head at one end and a weighing head that travels on two racks and tracks on the base frame and can be clamped to the base at any desired position.

The weighing head measures torsional loads in either direction of rotation. It is equipped wth two face plates to which test specimens can be fastened. The one on the side toward the driving head is used for torsion tests and the other is used with an adjoining torsional fatigue machine to determine the relation between applied torsional load and angle of deflection before starting torsional fatigue tests. A fixed frame member of the fatigue machine is then substituted for the Baldwin weighing head face plate.

The drive head is powered by an electronically controlled, variable speed, direct current motor with a 20 to 1 speed range. However, by means of two gear ratios, spindle speed can be varied between 1 and 20 degrees

Continued on Page 44

It's an
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THROW
ROTATION
OF
CRANKSHAFT
ECCENTRIC SCREW
ADJUSTMENT
MICRO FEED
ADJUSTMENT

—that makes this portable crankshaft grinder practical

This view shows the grinding head in position on the crankshaft throw. The flexible shaft drives the grinding wheel from the 3/4 H.P. motor rated at 10,000 r.p.m.

This valuable tool is a product of Waterbury Tool, Division of Vickers Incorporated, Waterbury, Conn. It grinds the crankshaft throws on a majority of internal combustion engines of the in-line cylinder type. It's a big time and labor saver because it makes removal of the crankshaft unnecessary.

As you consider the operation of this tool, it is clear that the flexible shaft is the only drive element that could meet the operating conditions. It provides a positive drive for the grinding wheel while flexing up and down as the crankshaft revolves. And the shaft also makes it possible to grind the throw through each cylinder without moving the motor.

The combination of *positive drive with flexibility* provided by S.S.White flexible shafts has made practical many other portable tools—all time and labor savers. The success of these tools strongly suggests the development of others for speeding up operations now being done by slower and less efficient means.

THE FLEXIBLE SHAFT HANDBOOK, in its 260 pages, gives all the information and technical data needed to work out applications. A free copy will be mailed to any engineer who writes for it on his business letterhead and mentions his position.

S.S.WHITE INDUSTRIAL DIVISION
THE S. S. WHITE DENTAL MFG. CO.
DEPT. L 10 EAST 40th ST., NEW YORK 16, N. Y.
FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
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One of America's AAAA Industrial Enterprises another BIG job . . .

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Every job of fabrication by DOWNINGTOWN receives "special" attention—careful planning and supervision from blue print to the finished product. For over 30 years, we of DOWNINGTOWN have strongly believed in the theory that it's the "little extra cares and attentions" which count heavily toward continuing customer satisfaction. Our experience and research in the fabrication of various grades of Carbon Steel, Stainless Steels, Nickel-Clad, Stainless-Clad, Monel-Clad, Cupro-Nickel, Aluminum, etc., may be of help to you. We are *fully equipped* to handle complete jobs, within our limitations, in the correct alloys and methods of fabrication required to assure operating efficiency—and modern facilities are available for checking welding operations by X-RAY.

We also maintain a Heat Transfer Division under the direction and supervision of men thoroughly trained and experienced in this field.

Our Engineering Consultation is at your service to aid you in plans and specifications for definite jobs.

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Four of a kind — winning power to spare in this hand! The same winning power you draw when you specify Wisconsin Air-Cooled Engines for *your* equipment . . . compact, heavy-duty singles in two types ranging from 2 to 9 hp.; twin-cylinder models from 7 to 13 hp., and V-type 4-cylinder engines from 15 to 30 hp.

All models are designed for heavy-duty service — delivering "Most Hp. Hours" of on-the-job service.

All models are extremely compact . . . to fit the machine as well as the job.

All models are built to one standard of top-quality excellence in design, materials and precision construction.

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WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
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per minute and between 20 and 400 degrees per minute, thus giving a loading speed range of 1 to 400 degrees per minute. Angular measurements can be read to 0.1 degree by a vernier on the chuck at the power end.

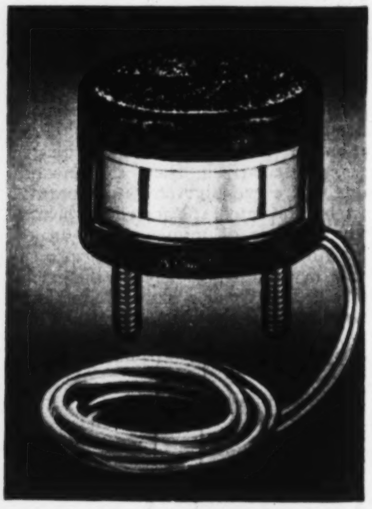
Torsional loads are applied in the weighing head to the well-known Emery capsule, as in nearly all testing machines manufactured by The Baldwin Locomotive Works. A standard Tate-Emery indicator takes the hydraulic pressure in a Bourdon tube that is restrained from deflecting by a pneumatic system sensitive to the air pressure changes that occur when the Bourdon tube disturbs a baffle plate over an air jet. A pressure sensitive bellows in the pneumatic system restrains deflection of the baffle and Bourdon tube through an iso-elastic spring* and thereby activates the indicator hand with the resulting extension of the highly accurate spring.

Four load ranges are available for torsional tests: 10,000; 50,000; 200,000; and 1,000,000 inch pounds. On each range the accuracy is $^1/_2$ percent.

* Trade Mark Registered, U. S. Patent Office.

New Recording Head for Magnetic Tape

The Indiana Steel Products Co. announces completion of the development program for their new magnetic tape recording head, Model TD-704. Thoroughly tested and approved, this new head, used for both recording and playback, features high output, maximum frequency response, extremely low hum level, compact size, and efficient performance with all available quarter-inch tapes



Designed for new equipment, it can also be used on existing machines with slight circuit changes necessary in some cases. Suggested applications are in home recorders, broadcast station equipment, machines for business dictation and records, test instruments, equipment used in educational methods, and other devices where the simplicity of magnetic tape recording offers many advantages.

This new Indiana Model TD-704 is used in high impedance circuits; and gives optimum results with a track .200 inches wide. Using tape with a coercive force of 300 oersteds at a speed of $7^1/_2$ inches per second, the operating bias level at 40 kc is 1.7 milliamperes and the audio signal current for standard recording level (as defined by RMA Standards) is 0.15 milliamperes. Recorded in such manner, the signal output from the high impedance playback winding is 5 millivolts. Impedance at 1000 cps is 1000 ohms.

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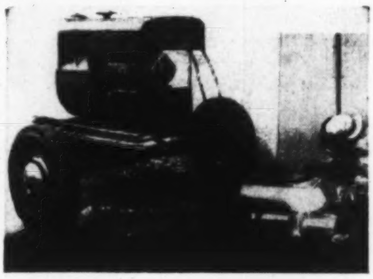
By using a laminated core structure, the 40 kc bias field strength is made substantially the same as the audio field strength for equal current. This reduces the bias requirements to less than 0.1 volt-ampere, for a tape having a coercive force of 300 oersteds. A high permeability shield minimizes electrostatic and magnetic pickup, resulting in an exceptionally low hum level. Overall dimensions are 7/8" × 7/8" × 5/8" deep. Immediate availability is offered.

For descriptive literature giving full details, write Dept. A-36, The Indiana Steel Products Co., 6 N. Michigan, Chicago 2, Ill.

New Light-Weight Welder Announced by G. E.



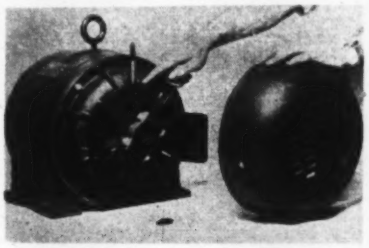
A new light-weight, engine-driven, d-c welder, designed for a wide range of general applications, has been announced by General Electric's Welding Equipment Division. Weighing only 660 pounds for a maximum of 250 amperes of welding current, the new welder can be easily transported on a pick-up truck, leaving ample truck capacity for other equipment.

It is powered by a Wisconsin VF-4 air-cooled engine, speed-ratio-coupled by a steel-core V-belt drive to a G-E Type WD-320 generator with 50 per cent duty cycle. A fully calibrated dual control permits the accurate setting of a desired welding current before the arc is struck.

The welder has a built-in auxiliary power outlet of 110 volts for the operation of lights and power tools, and stands on a full-length, rigid, welded steel base. The over-all length is 44⅛ inches, and it is 24½ inches wide and 35⅜ inches high. For greater portability, it can be furnished mounted on a two-wheeled, pneumatic-tired trailer with a standard 62-inch track.

Additional information about this new welder is given in Bulletin GEA-4886, available at the General Electric Company, Schenectady 5, N. Y.

New Corrosion-Resistant Textolite* Fan Now Standard Equipment on G-E Totally Enclosed Motors



G-E Tri-Clad totally enclosed, fan-cooled motors are now available in popular sizes from one to 20 hp equipped with a newly developed, corrosion-resistant Textolite cooling fan. The incorporation of this new fan in these standard, highly corrosion-resistant cast iron motors now makes them specially desirable for use in corrosive atmospheres. In addition, since the fan is non-sparking, it has also been incorporated in G-E totally enclosed motors designed for use in hazardous gas or dust locations. With the new fan now standard equipment on all these varieties, the use of standard, off-the-shelf motors for the majority of applications is now possible.

The fan is the result of exhaustive research, involving various materials and exacting tests. It has all the desirable features of metal fans, yet it is relatively inert to most corrosive atmospheres encountered in the chemical and allied industries. In addition, it has adequate strength to withstand rotational and assembly stresses. A feature of its design is the compression web at the inner face of the hub. This web not only supports some of the compression force, but also serves as a barrier to prevent liquids from passing directly through the fan and coming in contact with the bearing seal.

* Reg. U. S. Pat. Office.

High Pressure Pumps

A new design development of particular interest to users of high pressure pumps has been announced recently by The Aldrich Pump Co., Allentown, Pa.

This company has standardized the design of 6" stroke Triplex, Quintuplex, Septuplex and Nonuplex and 7", 7½", and 8" stroke Quintuplex, Septuplex and Nonuplex Pumps to permit use of identical wearing parts such as bearings, crossheads, wristpins and valves regardless of plunger diameter and number of plungers.

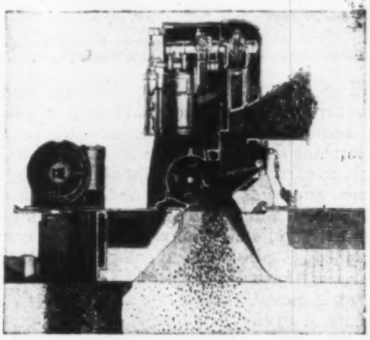
Increases in capacity are accomplished by increasing the number of pumping units. Pumps are supplied with 3, 5, 7, and 9 plungers.

In the 6" stroke line, the Triplex has a 300 HP rating, the Quintuplex has 500 HP, the Septuplex has 700 HP and the Nonuplex carries the HP rating to 900. The 7", 7½" and 8" stroke pumps carrying the ratings from 1300 HP to 2400 HP.

Ring joint construction to all flanges can be incorporated, and, if interchangeability of plunger sizes is desired, stuffing box linings can be provided.

This type of design over a wide range of sizes will cut down investment in spare parts and will decrease inventory of spare parts. It will also greatly reduce complications in ordering and accidental duplication of parts.

New Spreader-Type Stoker Announced



Complete, economical combustion of any grade of coal, even lignite, is possible with the recently announced Westinghouse "Centrafire" spreader-type industrial stoker.

In the new stoker, coal is trajected by an air cooled, hydraulic motor-driven rotor so that it falls evenly over the entire length of a Westinghouse Link-Grate. Undulation of the central grate keeps the fuel bed active and moving toward the ash discharge grates

Continued on Page 46

Box car builder saves $2925 a day —CAN YOU?

General Electric's money-saving pack of facts: *manual—film—review booklets.*

Get these facts to your key men and see how much you can save

- **WITH RESISTANCE WELDING, a box car builder cut costs by $2925.**
- **WITH RESISTANCE WELDING, a small transformer manufacturer saved $84,000 per year.**
- **WITH RESISTANCE WELDING, a radio tube maker stepped production up to an *unprecedented 2,500 per day.***

In your plant, too, savings and production feats like these are possible—when your key personnel *know* the up-to-the-minute facts on resistance welding—*know* how to put them to work on your problems. And it's so easy to get the facts to them *now*—at no cost.

***FREE* to business management**

Examine the General Electric *Resistance Welding Manual* free of charge. It covers every phase of resistance welding from a glossary of welding terms to specific industrial applications in plants like yours. It tells *where* resistance welding can be used—***how* it can be used—exactly** *what* benefits you can expect from it. It's written by experts, *without sales bias*, in a language your men can easily understand. Look through it. Satisfy yourself that it will pay off.

Get a *FREE* showing of the film

Your key personnel will get a kick learning the newest facts about resistance welding in this modern, absorbing, *visual* way. Here's a General Electric sound film in full color that wallops across its ideas — actually *shows* you how resistance welding is building better products for less in plants like yours. It's prepared by resistance-welding specialists in terms that are grasped readily. Show it to your key men.

ACT NOW! Don't delay. Remember—resistance welding saves you money in *five* ways—and does a better job, too. So start the ball rolling by filling in the coupon below and we'll rush you a copy of the G-E *Resistance Welding Manual*. *And*, with it, we'll tell you how to arrange for a free showing of the film.

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Attach to your business letterhead

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Please send me a sample copy of the G-E *Resistance Welding Manual* without cost or obligation, with details on how I can arrange for a FREE SHOWING of the film. (Extra copies at regular manual price—$1.00.)

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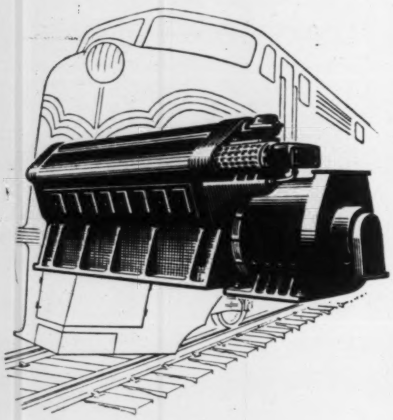

dieselization

Diesel engines in railroad locomotives are piling up an enviable trouble-free performance record. Many castings in these engines contain specified Molybdenum contents.

When wear or heat must be resisted, and high strengths are required, the use of Molybdenum in cast iron is becoming more and more routine.

The listing of a cylinder liner for Diesel use in railroad locomotives containing 3.20% Carbon, 1.90% Silicon, 0.85% Manganese, with 0.20% Chromium, 0.40% Molybdenum and 0.45% Nickel added can be found on page 10 of our new booklet—"Applications of Molybdenum Cast Irons."

Dozens of other alloy cast iron compositions used in Diesel engines, as well as hundreds of other Molybdenum-containing compositions are similarly listed in this new booklet. Write for it!

Climax Molybdenum Company
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New York City

Please send your FREE BOOKLET "Applications of Molybdenum Cast Irons"

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MOLY

ME-12 F9

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at the sides. Ashes are discharged from the furnace without interrupting the coal feed, reducing load or loss of steam pressure.

A deficiency of primary air rising through the central Link-Grate is deliberately maintained. Resulting monoxides are burned in a turbulent secondary air supply above the trajectory of incoming fuels. An increased supply of the metered primary air is admitted through the side areas of the grate and ash-discharge grates to provide complete combustion.

Coal is fed to the rotor by two long-stroke, slow-speed rams. A coal-feed equalizer plate driven from the rotor oscillates across the incoming fuel to assure a continuous feed whether the coal is wet or dry.

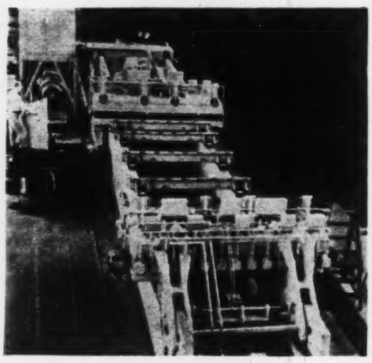
One constant speed motor or turbine supplies oil pressure for all controls and drives. Eliminating all chain drives, this hydraulic drive permits maintaining accurately any preset fuel-air ratio.

Additional information may be obtained from the Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa.

Hydraulic Plate Stretcher-Leveller of 1000 Ton Capacity

A stretcher-leveller of special design, believed to be the largest in the world, was recently incorporated into the production line of one of the greatest steel plate mills of the U.S.

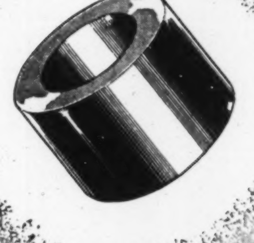
The machine which was built by Hydropress, Inc., 570 Lexington Ave., New York, N. Y., is of the self-contained oil hydraulic type, has a capacity of 1000 ton, and handles plate and sheet up to 11 ft. wide and 31 ft. long. By stretching, excellent results in regard to the flatness and properties of the plates, even on severely warped material, were obtained.



The illustration shows the stretcher-leveller on the test stand after shop erection. A bed of welded construction absorbs all stretching forces so that the foundations have only to carry the dead weight of the machine. Two gripheads are provided. The main griphead is actuated by the hydraulic stretching cylinder, while the position of the other griphead is adjustable to compensate for the varying length of the plates. This adjustable head is movable along the stretcher bed by means of an electric motor and suitable drive. It is secured in operating position by two heavy locking pins which are operated by air cylinders. Wedge-shaped shoes of special design in the throat of the gripheads insure a firm gripping of the plates to withstand the biggest stretching forces.

A straightening device in front of the gripheads is provided to flatten a warped or bent plate end, thus facilitating the feeding of the plate into the gripjaws. The movement of the straightening ledge is accomplished by means of remote controlled air cylinders.

WORKS WHERE OTHERS WON'T



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GRAPHITE METALLIZING CORPORATION
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A plate support consisting of five movable carriages makes loading and unloading of the plate a very simple process.

All movements and actions are performed by remote control from the operating panel. A hand lever on the operating stand governs the speed and direction of the movement of the main griphead, whereas the traveling gear and locking device of the adjustable griphead, the gripping jaws, the straightening device, and the pump motor are controlled by push buttons.

Pressure adjustment over a wide range is provided for handling thinner and narrower plates at the accurate required-pressure. The amount of stretching is shown on an instrument of the dial type which is automatically caused to indicate the stretch when the actual stretching operation starts.

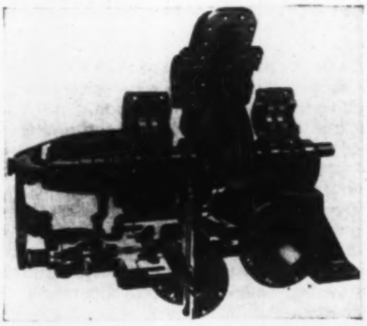
Bubbler Meter

Gas or liquid purge rates are measured in familiar flow units (i.e. cubic feet per hour of air or gallons per hour of water) by a new purge service flowmeter.

The "Bubbler type" purge meter is an adaptation of the "Flowrator" instrument that includes a built-in needle valve for close control of purge rates. It covers the range of measurement generally accepted as standard for bubbler installations. The unit consists simply of a Pyrex or stainless steel ball-shaped float, a precision-bore Pyrex metering tube and a die-cast body which houses the needle-type control valve.

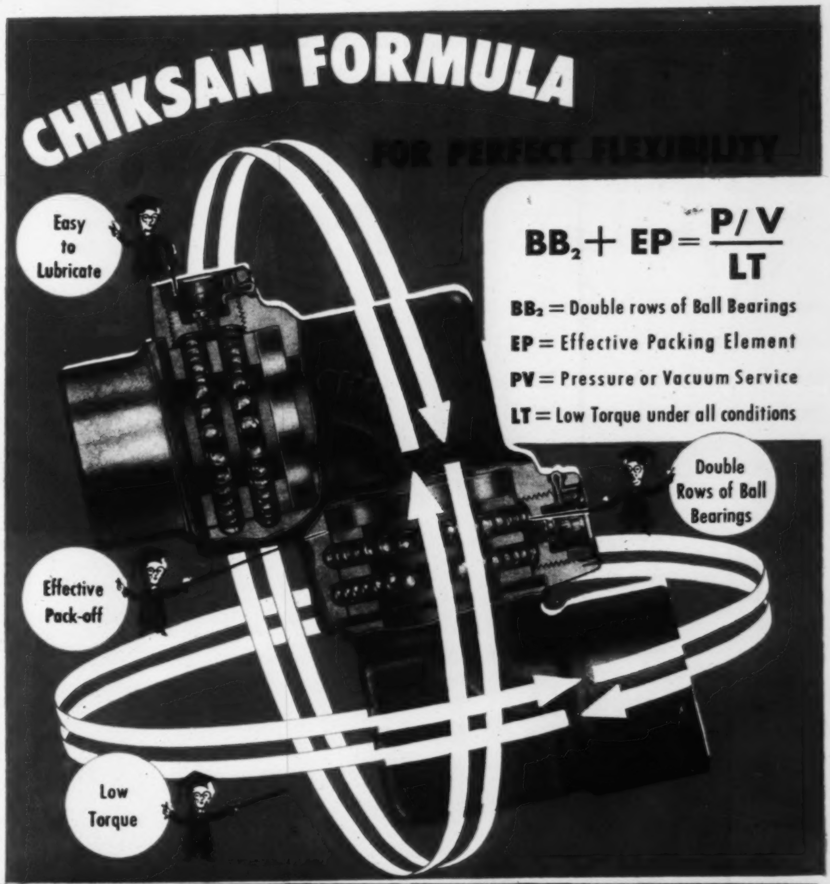
Its use with liquid level, fluid flow and specific gravity measuring instruments is fully described in a recent bulletin #7A-0. Write Fischer & Porter Co., Hatboro, Pa.

Westinghouse "Typee" Turbine Announced



A new all-weather general purpose turbine for driving industrial pumps, fans, blowers, compressors, paper machinery, and small generators, the "Typee", has been announced by the Westinghouse Electric Corp. A choice

Continued on Page 48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FOR PERFECT FLEXIBILITY
BB₂ + EP = P/V / LT
BB₂ = Double rows of Ball Bearings
EP = Effective Packing Element
PV = Pressure or Vacuum Service
LT = Low Torque under all conditions
Easy to Lubricate
Double Rows of Ball Bearings
Effective Pack-off
Low Torque

The CHIKSAN FORMULA
MAY BE THE ANSWER TO *Your* PROBLEM

Chiksan flexibility is so precisely engineered that the elements which provide for easy turning and perfect seal under pressure or vacuum can be stated in a few simple symbols. This streamlined design, expressed in precision manufacture, has won world-wide acceptance for Chiksan Ball-Bearing Swivel Joints wherever movement or rotation is required in pipe lines handling liquids, vapors and gases . . . in aircraft . . . electronics . . . railroads . . . chemical and food processing plants . . . refineries . . . marine installations . . . open hearth furnaces and rolling mills . . . and hundreds of other applications. The new Chiksan Catalog illustrates and describes over 500 different Types, Styles and Sizes. Ask for catalog No. 48.

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No engineer concerned with designing, applying, operating or servicing equipment for these active fields can afford to miss this outstanding display of progress. So plan now to attend —note the date.

Under Auspices of American Society of Heating & Ventilating Engineers.

MANAGEMENT INTERNATIONAL EXPOSITION COMPANY

of three wheel sizes, 16-, 20-, and 25-inch, permits "Typee" turbines to be applied over a range of 5- to 1500-horsepower with steam conditions up to 600 lbs ga at 750° F, and speeds of 1000 to 7000 rpm. Equipped with heavy duty parts the turbine will operate at 1500 lbs ga at 950° F. Many parts are interchangeable between wheel sizes.

Efficient combination felt and labyrinth bearing seals protect the turbine's lubricating system from contamination so that neither torrential rain nor the presence of abrasive dust will affect its operation. Corrosion resistant materials are used liberally throughout.

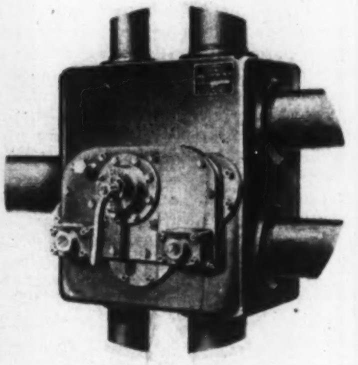
An overspeed trip simultaneously closes the governor valve and a heavy butterfly valve at a predetermined speed. Improved free-expansion center line support is arranged so that pipeline reaction is transmitted to the foundation.

The basic turbine is equipped with a shaft type governor, mounted in a rugged casing that completely protects the governor assembly and shaft end. The entire governor assembly can be replaced without disturbing the shaft. It is interchangeable between wheel sizes. "Typee" turbines may be equipped with special wide speed range governors where required.

Further information on the "Typee" turbine may be obtained from the Westinghouse Electric Corp., P.O. Box 868, Pittsburgh 30, Pa.

Cochrane Hydromatic Single Control Valve

A new publication issued by Cochrane Corp., Philadelphia, Pa., describes the Hydromatic Single Control Valve, now standard equipment on Cochrane Zeolite Softeners and Pressure Filters. With the Cochrane Hydromatic Valve, all the normal functions of a valve nest are integrated and controlled by one single valve.



The power for operation of the valve members is provided by the raw water itself, which results in smooth operation, as it confines the force required for positioning—either manual or automatic—to a miniature disc-type pilot valve. This permits gradual opening and closing of valve members, completely eliminating hydraulic shock and disruption of the bed within the container. The valve lever is easily moved with one hand, close attention by the operator is not required and damage due to careless operation is eliminated.

Principle features of the Cochrane Hydromatic Valve are: 1—four normal and two standby positions for flexibility; 2—pilot actuated for smooth operation; 3—integral rate controls for compactness; 4—flexible bellows valve for friction-free operations; 5—tight seating for reliable service.

• Keep Informed

Bulletin No. 4460 describes this valve and may be obtained by writing Cochrane Corp., 3142 No. 17th St., Philadelphia 32, Pa. In Canada, address Canadian General Electric Co., Ltd., 212 King Street West, Toronto 1, Ontario.

For Speed and Efficiency in Large Volume Print Production!

The new Ozalid Super-B produces Ozaprints at speeds up to 25 feet per minute. Its operation is continuous—with Exposure and Dry Development combined in one automatic operation.

It is the ideal machine for everyone with requirements in between those served by the Ozalid Streamliner and the Ozalid Printmaster . . . for everyone with large volume demands day after day . . . or with periodic peak loads that must be completed swiftly and economically.

All working parts are conveniently located —can be reached through side doors or by simply dropping panels. Expert engineering of every detail has produced simplified design . . . reduced maintenance routines to a minimum.

The usual daily maintenance consists of checking the ammonia supply . . . and sprinkling powder on the rubber developer belt.

In the Super-B (as in all Ozalid machines) the complete line of Ozalid sensitized papers, cloths, and films can be processed in the same manner, without interrupting machine production.

The operator merely feeds the original on desired type of Ozalid sensitized material into the Super-B—from which point the Ozalid print is conveyed automatically to the receiving tray without further handling. Anyone can do it!

New Turbine Pump

A new turbine pump for small diameter deep wells which is capable of developing water capacities up to 5000 gallons per hour from depths as great as 200 feet, is announced by the Peerless Pump Division of the Food Machinery & Chemical Corp. This new pump, designated as the "Peerless Champion," fills the gap in water production from deep wells 4 inches in diameter and larger which is often found between "domestic" water systems and the larger types of deep well turbine pumps.

The Peerless Champion is an open line shaft pump; bowl and shaft bearings are lubricated by the well's own water. No oil is used underground. Semi-open impellers, streamlined porcelain-enameled bowl sections, rubber bearings all contribute to its smooth water lifting with minimum losses due to turbulence. All shafting is stainless

Continued on Page 50

NEW

Helicoid Chemical Gage

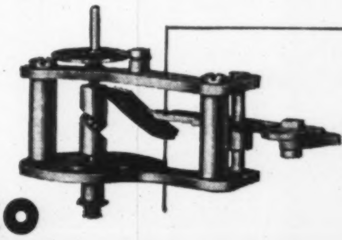
0
30
60
90
120
150
180
210
240
270
300

Here's a chemical gage for any pressure to 1600 p. s. i. and also for vacuum or compound ranges, and temperatures to 300° F.

● An accurate pressure gage for use where chemicals or viscous liquids either corrode or clog a Bourdon tube.

The diaphragm is "TEFLON" which resists practically all corrosive chemicals. The diaphragm chamber is supplied of any metal most suitable for the service.

Write for complete information about the new Helicoid Chemical Gage.



Only Helicoid Pressure Gages have the Helicoid Movement

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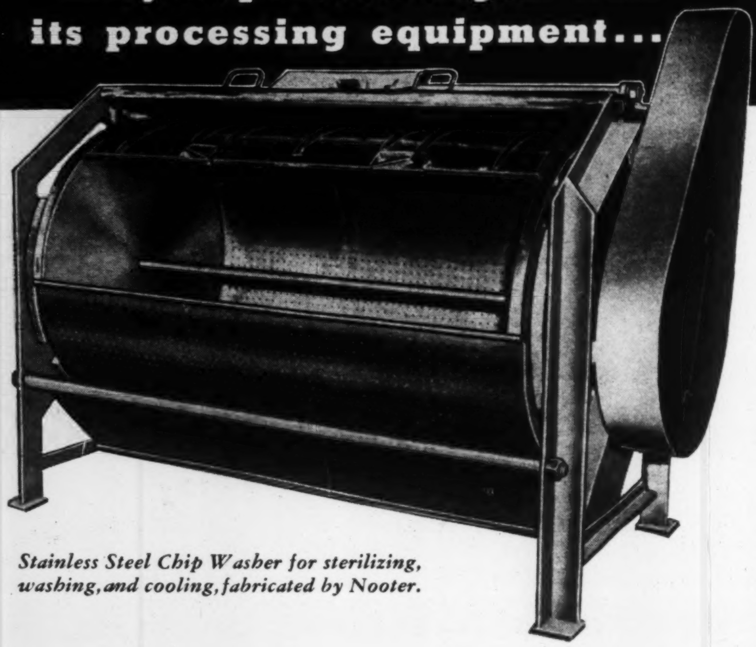
NOOTER FABRICATION
IS PROTECTION

Purity of product begins with its processing equipment...



Stainless Steel Chip Washer for sterilizing, washing, and cooling, fabricated by Nooter.

Equipment plays a vital role in maintaining high standards of purity and safety from contamination in the brewery and food processing industries. The Nooter DuraPure Welds can be depended upon to equal the corrosion-resistance and purity of the metals employed to meet the requirements of the processing equipment.

Nooter metallurgical specialists take extra precautions to insure the purity and strength of Nooter fabrications. Their long experience and thorough technical knowledge of metal properties and their behaviors, plus Nooter Dura-Pure Welding are your assurance of the highest possible standards of purity, strength and dependability.

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Handy Nooter, "Coupling and Flange Size Selector" is yours for the asking—Send for it!

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steel. Utilization of long cutless fluted rubber shaft bearings, spaced every five feet, are resistant to normal sand and abrasive conditions. Impellers are die cast bronze, hand finished and balanced.

The Champion is ideally adapted to a vertical tank pneumatic pressure system, being capable of developing pressures up to 90 lbs. or more. In addition to its application to water development from wells for the moderate gallonage requirements of commercial, light industrial and agricultural uses, it can be applied, close-coupled, to short settings for developing water from pits and sumps for supplying water for air conditioning, cooling tower service and other similar services where amounts of solids in suspension is negligible. With slight modifications the Champion may be applied to industrial process work, chemical plants and similar services.

All types of driving arrangements are available for the Champion: Standard direct-connected electric motor (1 to 10 h.p.); right angle geared drive for use with horizontal engines; multiple V-belt or flat belt pulley.

The Peerless Champion is completely described and illustrated in a new Bulletin No. B-200 which may be had by writing the manufacturer, Peerless Pump Division, Food Machinery & Chemical Corp., 301 West Avenue 26, Los Angeles 31, Calif.

"Eye-Dropper" Technique Proves Effective Method of Testing Steel, G-E Works Lab Reveals

Science has removed the eye-dropper from the family medicine cabinet and put it to work sampling molten steel at 2700 degrees Fahrenheit, according to engineers of the General Electric Co.

The "eye-dropper," as now used industrially in the Schenectady Works Laboratory, is a heat-resistant glass tube, about the diameter of a lead pencil and 18 inches long, with a rubber bulb at one end. Liquid steel fresh from the furnace is drawn up into the tube by squeezing the rubber bulb, just as an eye-dropper draws up medicine. The steel hardens into a smooth, homogeneous rod within five minutes, the glass is cracked from it, and the rod is ready to be checked for quality.

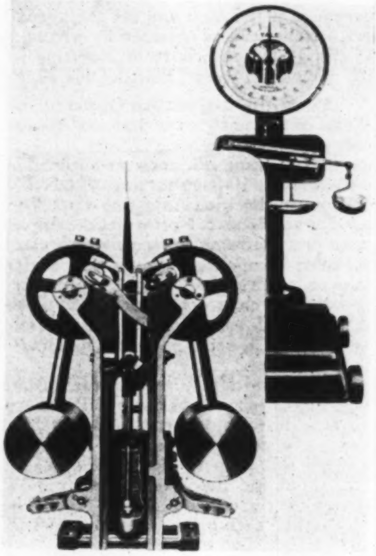
"Eye-dropper" samples may be prepared for analysis in a few minutes. Older techniques required long hours and involved such laborious operations as cutting a block from a hardened steel mass, machining it into a rod, and buffing it to a high polish.

Three men, wearing gloves and goggles, form a highly co-ordinated testing team. In a sequence that must take no more than 60 seconds, the first man removes a puddle from the heart of the furnace with a ladle on the end of a ten-foot pole. A second worker skins away the slag forming on the surface as the metal approaches the solidifying point. The third man then steps forward with the "eye-dropper" to suck up a glowing sample.

Cut in two and fitted into sockets before a spectrograph, the sample forms two electrodes of a high-voltage arc. An electric spark jumps between the two, giving off a light which varies with the makeup of the electrodes. By breaking up this light into its component colors with a prism, trained observers are able to judge the quality of any given batch of steel sampled by the "eye-dropper."

Yale Introduces Basically New Dial Scale Mechanism

The Magnetrol, a basically new dial scale mechanism just introduced by The Yale & Towne Mfg. Co., Philadelphia Division, achieves for the first time: (1) a straight line relationship between the platform load and pointer movement without specially filed cams, adaptations to prevent backlash or delicate adjustments of the angular relationships between sectors, (2) a reduction of service adjustments from the usual six or seven to only two and (3) full but light engagement between the pointer rack and pinion by means of a permanent magnet. Also noteworthy is the fact that all moving parts are mounted at three fixed centers in a single gray iron casting (the most dimensionally stable of many materials considered). Further, they move on precision ball bearing surfaces to minimize internal friction.



The net result is a new high level of sustained accuracy, ruggedness and long life.

The capacity of the mechanism under direct loading without any lever system is 25 lbs; its application to large industrial loads, up to 50 tons is a matter of lever linkage. Its guaranteed accuracy is one part in 1000, but accuracies of one part in 2000 are readily obtained. The dial head, which contains a 20-inch diameter reading-line dial chart, can be swiveled through 360°.

Inherent linearity between load and pointer displacement is achieved because the horizontal component of the displacement of the pendulum weight is directly proportional to both the draft band pull (over a *circular* drum) and to the vertical component of the displacement of a small roller rigidly affixed to that drum. Because the pendulum-roller system is in duplicate, and the two systems are opposed, the vertical movement of the rollers (see illustration) can be translated through a yoke-plate to a vertical rack. It is this rack which drives the fixed pinion on the pointer shaft.

Continued on Page 52

To study TWO *simultaneous* characteristics of *any* device

...use the DUMONT Type 279 *Dual-beam* CATHODE-RAY OSCILLOGRAPH

● Both the concomitant electrical and/or mechanical characteristics of a piece of equipment may be conveniently examined and recorded with a Du Mont Type 279 Dual-beam Cathode-ray Oscillograph.

For example: You can compare speed and vibration, velocity and acceleration, explosion time and rate of change of pressure, velocity and pressure changes on engine valves, and a multitude of other dual phenomena. Or you can examine a single phenomenon and an expanded, specific portion of it, simultaneously.

This oscillograph utilizes the dual-gun cathode-ray tube to generate and display two entirely separate and independent electron beams, which serve as inertialess, visual indicators. The circuits associated with each gun are also distinct and separate.

Where the application involves long time-intervals, the Type 279 is equipped with a d-c amplifier that is also excellent as an end stage for pre-amplifiers, such as used with strain gauges. For permanent records, Du Mont Types 271-A and/or 314 Oscillograph-record Cameras may be readily applied.

So, if your interest is petroleum research, ballistics, shock absorbers, boiler tubes, control mechanisms, timing devices, or practically any application involving two variables, be sure to investigate this Du Mont instrument.

● Consult us about the application of Du Mont Oscillography to your particular mechanical problem.
● Literature on request.

DUMONT *for Oscillography*

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PRESSURE PLUGS

These entirely new and exclusive precision-made plugs—for water, steam, air, oil and hydraulic pressure—are fully formed with the roundness and concentricity so desirable in a plug. Tests have proven that they materially reduce leakage on some applications and eliminate it entirely on others.

"Unbrako" Plugs—made by the manufacturer of the famous "Unbrako" Socket Screw Products—are available in National Pipe Thread sizes from ⅛" to 1¼". Write for detailed information and samples.

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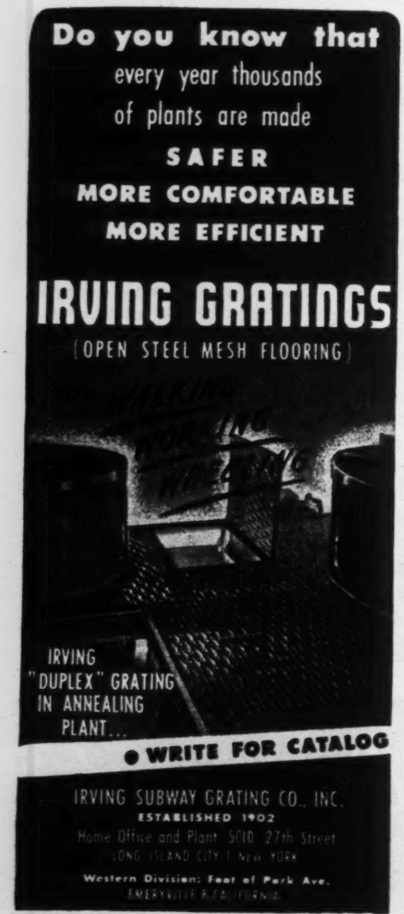
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(OPEN STEEL MESH FLOORING)

IRVING
"DUPLEX" GRATING
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PLANT...

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ESTABLISHED 1902
Home Office and Plant: 5010 27th Street
LONG ISLAND CITY 1, NEW YORK
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EMERYVILLE 8, CALIFORNIA

• Keep Informed . . .

The ingenious use of an Alnico magnet to keep the rack and pinion in engagement achieves two important functions at the same time: (1) it minimizes friction and (2) keeps teeth in *full* engagement at all times at exactly sufficient pressure.

Because there are no cams to file, sectors to orient, or tape lengths to control, there are only two points of adjustment. Ratio adjustment is accomplished by removable plugs within the pendulum weights. The center of gravity of the pendulum weights can thus be adjusted with vernier control. Pointer balancing is achieved in both directions at the pointer hub by means of lateral and vertical screws.

From a materials standpoint the design is interesting. The dash pot is filled with a special oil that flows at minus 40°F. Draft bands are made of a special alloy to prevent kinking, breaking, corrosion and creep. Weight arms, rack, pinion and yoke plates are of stainless steel for corrosion resistance. The rollers are of brass. Remaining parts are cadmium plated.

The mechanism is amply protected from moisture, water, dust and neglect. The dial head is sealed by rubber gaskets at the dial glass and back plate, and by oil at the column connection. Locking of the mechanism to prevent any possible damage from shock loads and such is accomplished with a single flip of a hand lever which (1) secures the pendulums in fixed neutral positions, and (2) lifts the draft rod so that load cannot be communicated to the draft bands.

Complete literature is available without charge from R. F. Miller, The Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia 24, Pa.

W-S Develops New Heating Cylinder

An improved heating cylinder for thermoplastics molding has been perfected by Watson-Stillman Co. It is now standard equipment on all W-S "Completeline" injection molding machines from 4 to 80 oz. capacity.

One significant advantage claimed by the manufacturer for this new design is its ability to deliver capacity shots of such "derating" materials as polystyrene without stuffing.

All surfaces in contact with plastic are chrome plated; the injection plunger is made of Nitralloy and is internally water cooled to prevent scoring or sticking.

The new nozzle adapter is secured by a tapered acme thread and seats firmly against maximum operating pressures. It permits rapid dismantling of nozzle and torpedo for cleaning with cylinder in place.

Calrod units provide the heat, and are set in grooves around the cylinder, thereby considerably increasing the area of contact and the consequent rate of heat transfer. These units are said to give service many times that of the types previously used.

• *BUSINESS CHANGES*

Haering Opening New Plant in Texas

D. W. Haering & Co., announce the opening of a unit in San Antonio, Texas. This new plant will provide increased facilities for their rapidly growing business. Provision has been made for increased laboratory, operating and warehouse space. This will give faster service to the rapidly developing industrial empire in the Southwest—as well as providing an adjunct to Haering Service throughout the entire country.

Nice Ball Bearing Co. Enlarges Factory

Due to a constantly increasing volume that has been maintained since the close of the war, the Nice Ball Bearing Co. has found it necessary to increase its manufacturing facilities by enlarging its plant at 30th & Hunting Park Avenue, Philadelphia 40, Penna.

A completely modern, separate office building is now being constructed, and the vacating of present office quarters will provide additional, much needed factory space.

The Nice Ball Bearing Co., one of the pioneers in the industry, has specialized in the manufacture of ball bearings for almost half a century.

• *LATEST CATALOGS*

SK Rotameters

A new 4-page folder, Bulletin 18-RA, pictures and briefly describes the various types of Rotameters and Flow Indicators manufactured by Schutte & Koerting Co.

Specifically designed to assist engineers in determining the type meter best suited for individual requirements, the folder lists each type of Universal Rotameter, Recording Rotameter, Special Rotameter and Flow Indicator offered and refers by number to the SK bulletin in which complete details are given.

Captions accompanying each photo indicate the principle applications for which the instrument is designed and list the available sizes. Copies can be obtained by writing for Bulletin 18-RA to Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Pa.

Position-Adjusting Control

Some of the many ways that modern automatic controls are helping industrial users to improve operating efficiency are outlined in a newly-revised, 40-page catalog, "L&N Electric Control, Position-Adjusting Type," just issued by the Leeds & Northrup Co. Applicable to practically any process which can be controlled by moving a valve, vane or damper, this electrically-actuated equipment is regulating temperature, pH, electrolytic conductivity and gas analysis in steel mills, chemical plants, paper mills, and hundreds of other industries.

Illustrated with pictures of actual installations, this catalog shows how the P.A.T. system provides complete control adaptable to nearly any control problem. The system provides full proportional control reaction with automatic droop-correction, obtained through the use of the accurate, reliable balance method both for measurement and control. In addition to the well-known Micromax instruments, the publication also lists the Speedomax line of Controllers for applications where unusual sensitivity and speed of response are required.

To receive a copy, just write to Leeds & Northrup Co., 4934 Stenton Avenue, Philadelphia 44, Pa., and ask for Catalog ND4A(1).

Pallet Handling

The Philadelphia Division of The Yale & Towne Mfg. Co. announces a new two-colored 20-page bulletin on pallet-system applications, hand lift and Worksaver pallet truck models, and recommended pallet design.

Six full pages are devoted to pictures illustrating uses of the pallet system. Typical uses include hauling goods from one process to another, hauling finished goods to the shipping room, storing goods both within the plant and in the plant yard, loading street trucks and rail cars, and performing general transportation jobs in and about the plant.

Two pages are devoted to drawings and text on recommended pallet design. Double-face reversible pallets, double-face nonre-

• Keep Informed

versible pallets, four-way entry pallets, and single-face pallets are discussed with reference to design problems which must be kept in mind when installing a system for use with standard handling equipment.

Four pages are devoted to cutaway illustrations of hand truck mechanisms, text on advantages of both mechanical and hydraulic lifting mechanisms, and three charts on the Easy-Lift J, Load King, and Load King H and Y model pallet trucks. These charts recommend the correct trucks for use with double-face and single-face pallets and give capacities, lift frame specifications, ground clearance, and structural data for the various models.

Five pages are devoted to the Worksaver. The Worksaver is a hand truck in that the operator guides it by the handle; it is a power truck in that both lifting and motivation are powered by battery. Capacity, weight, speeds, lift, dimensions, and electrical, mechanical and general characteristics are given for the pallet, tinplate, tilting fork, and nontilting fork Worksavers. Photos showing Worksavers in actual operations complete the bulletin.

In requesting copies of this bulletin please refer to Bulletin P-673.

Posture Chair for Draftsmen

Cramer Posture Chair Co., Inc., 1205 Charlotte, Kansas City 6, Mo., offers a posture chair designed by Draftsmen for Draftsmen.

A forward tilt Hi-Model chair engineered to provide proper posture seating for long neglected workers, who are in motion—or partially standing in the performance of their job.

These chairs come equipped with simple handwheel adjustments for seat height, seat depth, back height, and footring height; 2" ball bearing casters for ease of movement; genuine molded foam latex rubber cushions on seat and back for comfort; and removable covers on seat and back for dry cleaning or eventual replacement.

New Torquemeter Bulletin

SR-4* Torquemeters. Bulletin No. 275, 4 pages, covers (1) four standard Baldwin torquemeters of 2000, 5000, 12,000 and 30,000 in. lb. capacity based on SR-4 bonded resistance wire strain gages, (2) specially designed torquemeters for capacities of 30 to 750,000 in. lb. capacities with shaft diameters of $^1/_4$ in. to 18 in., and (3) instrumentation for indicating and recording torque measurements. The bulletin tells how to specify torquemeter requirements and shows how the torquemeter works. Various forms and sizes of meters and instruments are illustrated. Copies are available from Testing Equipment Department, Baldwin Locomotive Works, Philadelphia 42, Pa.

*Trade Mark U. S. Patent Office

How Corrosion By Salt and Salt Solutions Can Be Overcome

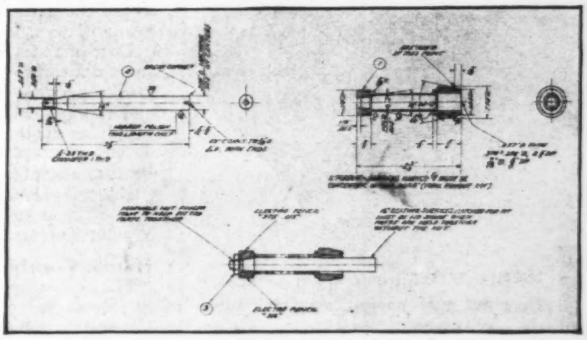
The part played by corrosion control in the production of salt, and in the use of brine solutions by chemical and food processors, is described in a new 20-page booklet just issued by The International Nickel Co., entitled "Salt as a Corrosion Problem."

The booklet contains a minimum of ancient history. Its contents are about equally divided between a discussion of corrosion problems solved by the salt industry, and equipment for handling brine solutions in the chemical and process industries.

"The American salt industry, with its high-purity requirements and low bulk prices, represents one of the major triumphs of chemical engineering science," the booklet

Continued on Page 54

with STEEL — the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished product.



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The small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Your investment in Arkwright Tracing Cloth is a trifling sum, compared to its returns in drawings kept permanently sharp and repeatedly useful!

Foresighted drafting departments regularly specify fine-woven, expertly bonded Arkwright, rather than perishable tracing paper, for *every drawing worth keeping for possible future use.*

Read the *Big Six Reasons* why Arkwright Tracing Cloth eases work, improves jobs, resists wear and time. Then send for generous samples and prove this superiority on your drawing board. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

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2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.

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ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

THE LUBRICANT
FOR
HEAVY
LOADS

LUBRIPLATE Lubricants are a paradox. They not only possess enormous film strength to withstand the heaviest loads but they function with minimum drag, hence conserve power. The "stay-put" quality of these unique lubricants means less frequent application and less lubricant consumption. Yes, they are most economical too. Write for particulars.

LUBRIPLATE

Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE

Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE

Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

LUBR PLATE
REFINING CO
DEALERS FROM COAST TO COAST
ONSULT YOUR CLASSIFIED TELEPHONE BOOK

• Keep Informed

points out. "But salt production was an old and basic industry long before chemical engineering was dreamt of. One reason for this apparent technical paradox is the alertness of modern salt producers to study and apply new engineering methods, and to adopt suitable equipment after test."

This publication is available without charge through The International Nickel Co., 67 Wall Street, New York, N. Y.

Truarc Specifications and Data Catalog

A complete Truarc Engineering Specifications & Data Catalog, with 28 pages of charts for all standard types of Truarc rings is now available upon request.

Data includes ring dimensions, housing and shaft dimensions, groove dimensions, thrust load capacities, materials, tensile strengths and types of finishes. There are also charts supplying engineering recommendations and Truarc ring specifications for standard ball bearing assemblies.

Requests should be made on company stationery and mailed to Truarc Division, Waldes Kohinoor, Long Island City 1, N. Y.

Hauck Combination Oil-Gas Burners

Hauck Manufacturing Co., 127-137 Tenth St., Brooklyn 15, N. Y., announce their new Catalog No. 408, just off press which illustrates and describes the Hauck Combination Oil-Gas Burner.

Due to fuel scarcities, many plants will need to change from gas to oil firing this winter. The Hauck Burner permits the fuel switching quickly and without any change in equipment or loss of production. It is being used for all phases of industrial heating applications.

Centralized Lubrication

"The Wheel That Squeaks Loudest Gets The Grease." You probably feel that this old saying belongs back in the horse-and-buggy era. Still it may illustrate the point in the 1948 edition of "Studies in Centralized Lubrication," recently issued by the Farval Corp., 3264 East 80th St., Cleveland 4, Ohio.

You may have installed Farval in the past to take care of some troublesome bearings and to thus get grease to your "squeaky wheel." If you have had this experience, you also found that Farval gave you these additional advantages: Eliminated bearing repair and expense—saved oiling labor—stopped lubricant waste—eliminated down time from lack of lubrication—increased output—improved safety conditions, etc.

Why not take advantage of these savings on the other machines throughout your plant? The Bulletin gives concrete examples of the saving that have been made on some of the machines in modern industry, and may suggest opportunities for a similar reduction in cost and increased output in your plant. Send for your copy of the Bulletin.

New, Lubricated Plug Valve

Section 5 of Valve Reference Book No. 39 has just been issued by Homestead Valve Manufacturing Co., Coraopolis, Pa., covering the Homestead-Reiser "Self-Seald" Lubricated Plug Valve. It offers general catalog data, descriptions, specifications, and prices on the units, parts and accessories.

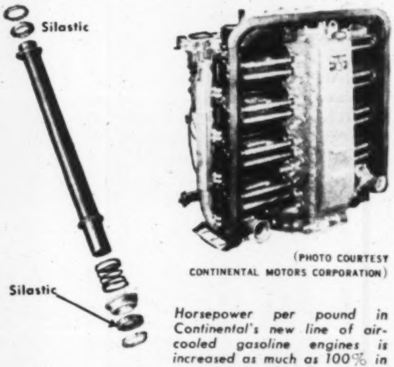
"First Aid" In War on Corrosion

To help industrial designers, engineers, and buyers cut the cost of important machine components and accessories, about 200 standard products for corrosive and high temperature service are listed in a new catalog by The International Nickel Co. Checked by manufacturers of each item, this new "Standard Specialties" catalog is the first complete compilation of products made of Monel, Nickel or Inconel and avail-

Silicone News
DC
SILICONES

More Power Per Pound†

Call it plain laziness or call it "divine discontent", some potent force has driven us to seek more concentrated motive power ever since man started to move on wheels. But each increase in horsepower per pound has increased operating temperatures and created a need for more heat resistant materials. Dow Corning Silicones help to supply that need in such major developments as the new air-cooled gasoline engine by Continental Motors Corporation of Detroit.



(PHOTO COURTESY CONTINENTAL MOTORS CORPORATION)

Horsepower per pound in Continental's new line of air-cooled gasoline engines is increased as much as 100% in engines below 250 hp . . . more than 300% (down from 2400 to 777 lbs.) in the horizontally opposed 8 cylinder 250 hp engine shown above. In this type of engine, Silastic gaskets are essential parts of the standard push-rod and tube assembly.*

Among the many problems solved by Continental engineers in designing this compact power plant, was the leakage of oil around the push-rod tube assembly. Hot oil and operating temperatures up to 500° F. severely limited the life of conventional gasketing materials. Continental engineers, however, knew about Silastic, the rubber-like Silicone by Dow Corning, and they asked for samples and technical assistance.

Silastic solved this problem because it is more heat-stable and more resistant to hot oils and to permanent deformation at temperatures above 200° F. than any other resilient material. Use of engines in sub-zero weather is not restricted by these gaskets of Silastic 161 because they are serviceable from —90° to 500° F. For more information about Silastic, ask for data sheet No. F-5C.

†See Silicone News, Dec. 1947, for story on 50% reduction in size and weight of electric motors made possible by Dow Corning Silicone Insulation.

*TRADE MARK REGISTERED U. S. PAT. OFF.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN
Atlanta • Chicago • Cleveland • Dallas
Los Angeles • New York
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning
FIRST IN SILICONES

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able economically from stock or from standard designs.

Among the hundreds of "Standard Specialties" described and illustrated under 47 general classifications are balls, floats, nails, bolts, pickling slings and hooks, thermostat parts, thermocouple protection tubes, pipe and pipe fittings, gaskets, valves, cathodes, grease fittings, tags, woodruff keys, wire rope, and vibration isolators.

Copies of this "Standard Specialties" catalog are offered to industrial purchasing agents, engineers, product designers, and other executives concerned with purchase and product specification, through The International Nickel Co., Inc., 67 Wall Street, New York.

New Cash-Acme Bulletin Available

Bulletin No. 265, describing the "Cash-Acme" Type B Pressure Reducing and Regulating Valve, has just been issued by A. W. Cash Valve Mfg. Co., Decatur, Ill.

This Bulletin gives recommendations covering installations and also contains capacity charts for water, air and steam.

Flexible Metallic Tubing

Pennsylvania Flexible Metallic Tubing Co., 7206 Power Lane, Philadelphia 42, Pa., announces Bulletin No. 52-9 which illustrates and describes their Penflex Flexible Metallic Interlocked Galvanized Steel Hose and Bronze Steam Hose.

Strain Rate Pacer

Bulletin 289, just issued by The Baldwin Locomotive Works, Philadelphia 42, Pa., describes and illustrates the new Strain Rate Pacer, a testing machine accessory designed to enable operators to maintain constant straining rates during the loading of test specimens.

"Little Giant" Packaged Boilers

A new Booklet has just been released by Union Iron Works, Erie, Pa., which describes their "Little Giant" Packaged Boilers, suitable for all firing methods. A complete boiler and furnace unit designed for the economical use of all fuels. Ten sizes—15 through 80 hp.—compact and complete—shipped fully assembled.

SK Steam Jet Blowers and Blast Nozzles

Steam Jet Blowers and Blast Nozzles for moving large volumes of gas at low drafts are described in new Bulletin 4-AB just released by Schutte & Koerting Co.

Tables, charts and drawings give complete data on dimensions, connection sizes, capacities and costs. Colored diagrams, with explanations, are used to illustrate typical applications of various types of blowers and blast nozzles.

Copies can be obtained by writing for Bulletin 4-AB to Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Pa.

Lunkenheimer "Renewo" Valve Threesome

An illustrated 12-page folder No. 577, introducing the Lunkenheimer "Renewo" Valve Threesome is now available from The Lunkenheimer Co., Cincinnati 14, Ohio. This new literature illustrates in cutaway fashion the interchangeability of parts by which users of regular type "Renewo" Valves can convert to either Nickel Alloy or Stainless Steel Plug Type Valves by simply changing seats and discs.

The renewable features of this new valve line reduce original and maintenance expense

Continued on Page 56

It's Powered Right when It's Powered by Briggs & Stratton

The dependability and efficiency of "powered" equipment depends on the engine that drives it.

Specify Briggs & Stratton 4-cycle, air-cooled engines. It's the right power for the most exacting requirements. No other single cylinder, air-cooled, gasoline engine gives you the same value, performance, and dependability.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wis., U. S. A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES
World Wide
FACTORY SUPERVISED SERVICE

by lowering stock room investment, simplifying ordering and handling, and facilitating repairs. The complete line is featured in Globe and Angle types, rated at 200 and 300 lb. S.P. The "NS5" Nickel Alloy seats and discs have a hardness of 330 Brinell and the Stainless Steel a hardness of 500 Brinell. Helpful tables of dimensions are also included.

Pump and Heater Sets

The Peabody Engineering Corp., 580 Fifth Ave., New York, N. Y., has just published a four-page bulletin in the complete line of Duplex Pump and Heater Sets. Complete with diagrammatic layouts and photos of a rather wide range of Pump and Heater Sets, this new bulletin also shows in some detail the various elements and factors that must be considered by anyone in ordering a Pump and Heater Set for any specified purposes and applications. Copies are available upon request.

Facts About Flexible Shafting

The F. W. Stewart Manufacturing Corp. has just issued an interesting, illustrated booklet "Facts about Flexible Shafting." In it are shown a variety of uses for flexible shafts in the industrial field. It describes with diagrams how to eliminate alignment problems such as miter gears, universal joints, spur gears and other space wasting and inefficient power transfer units. It also tells how Circle Ess Flexible Shafting is built to give long service. Write for your copy of this valuable booklet to F. W. Stewart Mfg. Corp., 4311 Ravenswood Avenue, Chicago 13, Ill.

Limit-Load Conoidal Fans

Buffalo Forge Co., 148 Mortimer St., Buffalo 2, N. Y., have just issued a new Bulletin No. 3675, Type "LL" Limit-Load Conoidal Fans—68 pages packed full of valuable information and profusely illustrated. Contains tables, curves, charts and other engineering data.

Nickel Alloys

The International Nickel Co., Inc. revised list "A" of current publications on Nickel Alloy Steels, Nickel Cast Irons, Nickel Brass & Bronzes, and Nickel Plating is now available. Publications offered cover the production, fabrication, properties and uses of Nickel Alloys for industrial applications, and the production, properties and use of Nickel electrodeposits.

Analytical Instruments for Science and Industry

Consolidated Engineering Corp., 620 North Lake Ave., Pasadena, Cal., announce their new General Catalog No. 1300A which covers all the instruments made by them, which include: Spectrometers, Leak Detectors, Recording Oscillographs, Electrical Computors, Vibrative Pick-Ups and Static-Dynamic Measuring and Recording Instruments.

Scotch Boilers

A new bulletin on this subject is available from The Brownell Co., 446 N. Findlay St., Dayton 1, Ohio. The line comprises twelve sizes ranging in capacity from 10 to 180 hp; 1,400 to 25,500 sq. ft. steam radiation. The manufacturer states that the low construction of the Scotch boiler is a distinct advantage where head room is limited; no casing is needed; insulating is easy; efficiency is good. This type of boiler can be used for power, heating, and processing. A copy of the bulletin (No. B-8) will be sent upon request.

Flowrites

The Condenser Service & Engineering Co., Hoboken, N. J., has just completed a bulletin on Inserts or Flowrites. This is a new discovery which has worked successfully in prolonging the life of condenser and heat exchanger tubes. The bulletin is available upon request.

Cleaning Plugs

The Condenser Service & Engineering Co., Hoboken, N. J., has just completed a new bulletin on Conco Cleaning Plugs. This plug is used for cleaning algae (slime) deposits and scale deposits on the inside of condenser and heat exchanger tubes.

Duration-Adjusting Type Temperature Control

A newly-revised 36-page catalog issued by Leeds & Northrup presents the latest developments in the company's Duration-Adjusting Type of L&M Electric Control for regulating temperature of electric furnaces, salt pots, and certain fuel-fired furnaces. Illustrated with numerous pictures of actual installations, this publication describes the unique D.A.T. method for controlling heat input by supplying electric power (or heat from combustion) in impulses of controlled duration. It shows how this system provides the full benefits of proportional control, with automatic droop correction.

The exceptional performance of this system is demonstrated by actual test curves which illustrate how D.A.T., according to the manufacturers, is limiting the temperature swings of furnace heating elements, improving

TY DS PEERLESS *Centrifugal* PUMPS

PROCESS SERVICES
ABRASIVE AND CORROSIVE LIQUIDS

TYPE **DS**
ENCLOSED IMPELLER

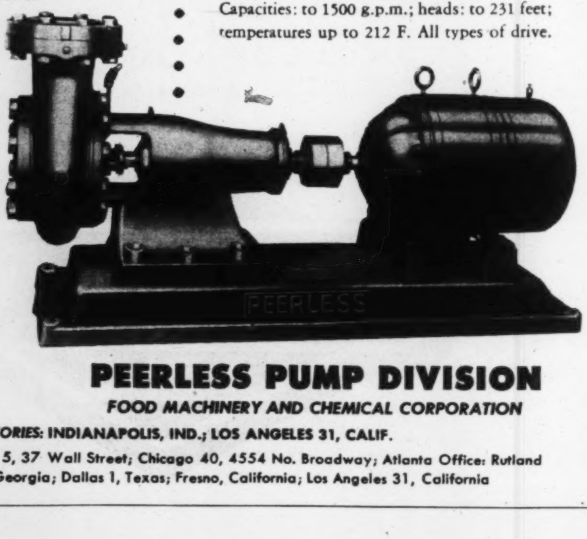
Application:

The Type DS pump is a general purpose process pump with enclosed impeller. Handles clear liquids in a variety of services and solutions which may be corrosive. Single-stage, single-end suction design. Capacities: up to 600 g.p.m.; heads up to 231 feet; temperatures up to 212 F. All types of drive.

TYPE **DSO**
OPEN IMPELLER

Application:

The Type DSO pump has essentially the characteristics and applications as the Type DS. However, the Type DSO utilizes an open impeller with impeller vanes on back of shroud to permit pumping of fluids with solids in suspension, brines, sludges and the like. Capacities: to 1500 g.p.m.; heads: to 231 feet; temperatures up to 212 F. All types of drive.



Write for descriptive and illustrated Bulletin No. 803.

fmc
PEERLESS PUMPS

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
FACTORIES: INDIANAPOLIS, IND.; LOS ANGELES 31, CALIF.
District Offices: New York 5, 37 Wall Street; Chicago 40, 4554 No. Broadway; Atlanta Office: Rutland Building, Decatur, Georgia; Dallas 1, Texas; Fresno, California; Los Angeles 31, California

heater life and providing highly accurate and uniform control of furnace temperature at the specified point. In addition to the well-known Micromax control instruments, the catalog also lists the Speedomax line of controllers, for applications where unusual speed and sensitivity are required.

To receive a copy, just write to Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., and ask for Catalog ND4A(2).

Flexible Metallic Tubing

"Application of Flexible Tubing for Air, Oil, Steam, Gases and Volatiles," is the title of a new Folder just issued by Pennsylvania Flexible Metallic Tubing Co., 7206 Power Lane, Philadelphia 42, Pa.

Shows construction, assemblies and fittings and the various applications. Crammed full of factual data on Flexible Metallic Tubing.

"Fluid" Method of Cracking Oil Now in Dominant Position

Although the Fluid catalytic-cracking process is little more than six commercial years old, it has already assumed a dominant role in the oil refining industry, according to "The Kelloggram," published by The M. W. Kellogg Co., petroleum engineers of Jersey City, N. J.

An indication of the importance attached to this process by oil refiners of the Western Hemisphere in their current race to modernize their facilities, can be seen in the fact that Kellogg is currently designing and building 14 "cat-crackers" scattered from Argentina to Canada, representing an investment in the hundreds of million dollars bracket.

This latest issue of the Kelloggram traces the major improvements in Fluid "cats" from the first commercial unit at Baton Rouge in 1942 to the latest unit at Montreal which was started recently. Today's processing techniques—as differentiated from the techniques adopted during the war—are also discussed in this 8-page issue which is abundantly illustrated with photographs of new design changes.

Lending authority to this article is the fact that M. W. Kellogg has built or is building a total of 42 cat-crackers in the Western Hemisphere with a combined yearly charge capacity of approximately 250 million barrels. Currently more than 70% of the world's Fluid catalytic-cracking is carried out in Kellogg units.

Constant Differential Oil Burning System

Peabody Engineering Corp., 580 Fifth Ave., New York, N. Y., has recently reprinted their "Constant Differential Oil Burning System Bulletin No. 109." General distribution on this has long been restricted but copies of their new bulletin No. 109-A are now available upon direct request to Peabody.

Completely diagrammed and charted, Peabody's Bulletin No. 109-A not only explains how the constant differential system operates but also illustrates, in cut-away fashion, the atomizer itself with complete explanation of how extreme fluctuating loads are handled under positive regulation with full flame control.

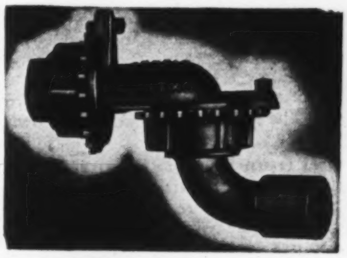
High Pressure Pumps

New Aldrich Data Sheet 62 pictures and describes various types and sizes of High Pressure Pumps designed and built for pipe line, oil field and refinery service.

Contents of this catalog include sections on the Aldrich-Groff "Powr-Savr" Controllable Capacity Pumps, Triplex, and Quintuplex Pumps and the most recent additions to the Aldrich line, the Septuplex and Nonuplex Pumps.

Continued on Page 58

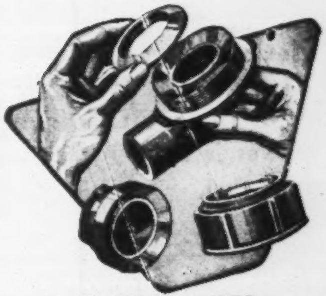
for SAFETY and SIMPLICITY—



Style "H"

FLEXO JOINTS

The FLEXIBILITY of Hose—
The STRENGTH of Pipe.



The safety of a moving pipe line is no greater than the safety of its connections. That's why Flexo Joints are the standard wherever flexible or swing joints are required for steam, air, gas, water, oil or other fluids. Swivel through full 360° with no flow restrictions.

Style "A"

Style "B"

Style "F"

4 SIMPLE PARTS

No small parts, no springs, no ground surfaces to wear. Fully enclosed from grit and dirt. In four styles—standard pipe sizes from ¼" to 3".

WRITE FOR DETAILS AND SPECIFICATIONS.

FLEXO SUPPLY COMPANY, Inc., 4652 PAGE BLVD.
St. Louis (13).

In Canada: S. A. ARMSTRONG, 115 Dupont St., Toronto (5), Ontario

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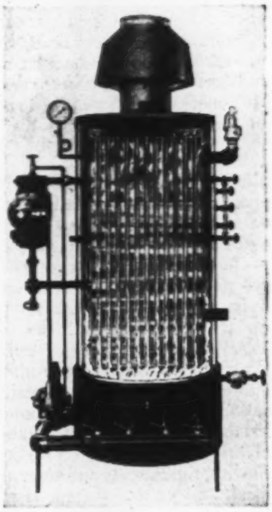
EVERY UNIT AN "individual" UNIT



The KANE Boiler is built to A.S.M.E. specifications, in sizes to 30 H.P.

the KANE BOILER PACKAGE

Each KANE BOILER PACKAGE is carefully considered by us as an "individual" job—from the customer's requirements to the finished unit. And each BOILER PACKAGE is a compact, self-contained steam source that includes: the correctly sized KANE Automatic Gas-Fired Boiler complete with gas burner and controls to maintain required steam pressure; and an M-K-O Automatic Boiler Feed system designed to return condensate and supply make-up water as required for highest operating efficiency.

Engineered Steam at its best, with four decades of experience at your disposal—so, send your steam problem to us for study and recommendation.

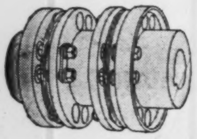
ENGINEERED STEAM AT ITS BEST

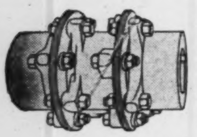
MEARS-KANE-OFELDT INC.
1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.
FOUR DECADES OF AUTOMATIC GAS-FIRED BOILER MANUFACTURING EXPERIENCE

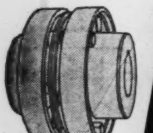
THOMAS
Flexible ALL METAL
COUPLINGS

Engineered to stand up on the toughest jobs, Thomas Flexible Couplings do not depend on springs, gears, rubber or grids to drive. All power is transmitted by direct pull.

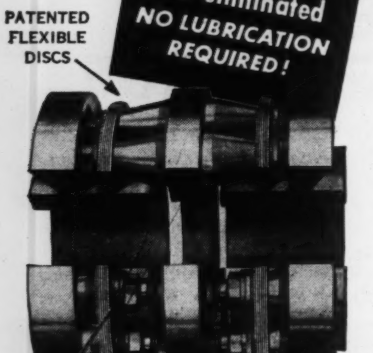
The standard line of Thomas Couplings meets practically all requirements. But if unusual conditions exist we are equipped to engineer and build special couplings.







BACKLASH
FRICTION
WEAR and
CROSS-PULL
are eliminated
NO LUBRICATION REQUIRED!



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

Write for New Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

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Two unusual application stories as well as information on pump drives, Alleviators and Kosmos Plungers are also included. The catalog contains numerous installation photos of Aldrich Pumps in action.

Copies of this catalog can be obtained by writing to The Aldrich Pump Co., Allentown, Pa.

Relief from Bearing Wear Grief

A new booklet entitled "Relief from Bearing Wear Grief" reveals a new answer to some old problems of power transmission loss and prematurely worn bearings. This booklet reveals how many plants are preventing the destructive waste of downtime caused by bearing failure, shaft failure and damaged equipment through the improper coupling of rotating shafts.

This booklet describes the functions of flexible couplings. A thorough explanation and analysis is given to the principles by which couplings operate and their importance in relationship to the equipment it connects.

This booklet presents practical helps to design engineers, plant engineers, master mechanics and maintenance men on how the use of proper flexible couplings prevents downtime caused by bearing failure, shaft failure and damaged equipment.

In addition, description and illustrations show how the operation of the American Flexible Coupling compensates for end thrust and the three types of shaft misalignment. A section of the booklet describes the maintenance of this coupling and how its life can be renewed at a minimum of cost in downtime and labor. Entitled "Relief from Bearing Wear Grief," this 24-page three-color booklet is published and available from Dept. C-1, the American Flexible Coupling Co., Erie, Pa., div. of the J. A. Zurn Mfg. Co.

Industrial Trucks

A quick but informative survey of its entire line of gasoline-powered, pneumatic-tired industrial trucks may be found in catalog Number 1074, published by the Hyster Co., 2902-51 N.E. Clockamas St., Portland, Ore. Included in the booklet are model views and detailed description covering three sizes of lift trucks, two Straddle Truck models and the 10,000 pound capacity Karry Kane.

Guide to Bakelite and Vinylite Plastics

"A Simplified Guide to 'Bakelite' and 'Vinylite' Plastics" is the title of a new 24-page booklet published by Bakelite Corp., a comprehensive, profusely illustrated catalog of the many types of "Bakelite" and "Vinylite" product. This book serves as a businessman's guide to both thermosetting and thermoplastic plastics. The booklet describes phenolic molding plastics, polystyrene molding plastics, laminating plastics, cast resins, resins for coatings, coatings for adhesives, bonding materials, impregnating and sealing materials, polyethylene plastics, "Vinylite" elastomeric plastics, rigid sheets and sheeting, and resins, fibers, and yarns. Copies of this booklet are available upon request to Bakelite Corp., 30 East 42nd St., New York, N.Y.

S.S. White Nylon Plastics Molding

A new 4-page bulletin has been issued by S.S. White Dental Mfg. Co., Plastics Division, describing S.S. White Nylon molded products and custom molding facilities. The new bulletin contains valuable data on Nylon properties and characteristics and suggests many possible uses for Nylon in industrial applications. Included are descriptions and sizes of stock Nylon items such as valve seats and washers and rods and flat stock. Copy of this Bulletin No. P-4801 may be obtained from The Plastics Division, S. S. White Dental Mfg. Co., 10 East 40th Street, New York, 16, N. Y.

DROP FORGINGS

Let us quote on your requirements.

Producers of Quality Forgings for over 25 years.

Baldt
ANCHOR, CHAIN & FORGE DIVISION
of
The Boston Metals Company
CHESTER, PA.

New Heavy Duty Steam Valve

A 28-page bulletin, 8-B, issued by Schutte & Koerting Co., pictures and describes their line of Boiler Stop Valves, Check Valves, Stop Check Valves and Triple Duty Valves for medium and high pressure service from 250 lbs. to 2100 lbs., and temperatures up to 1150°F.

The bulletin contains complete information on the construction, parts and materials used in the manufacture of these valves, in addition to dimensions and performance data.

Copies can be obtained by writing for Bulletin 8-B to Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Pa.

Automatic Coal Sampler

Heyl & Patterson, Inc., 55 Water St., Pittsburgh 27, Pa., have just issued a new Bulletin entitled "What Makes the H & P Thorsten Automatic Coal Sampler Tick?" Thorsten Automatic Samplers are adaptable to any conveying system and can be used with belt or flight conveyors, elevators or chutes. There are two types, the Reciprocating Sampler for Wide Streams of Coal and Stationary Sampler for Narrow Streams of Coal.

The Thorsten Sampling Crusher is also shown. It is a two-stage, cone-type vertical crusher with a sampling device in each stage.

The Thorsten Sampling System, using Thorsten Samplers and Thorsten Sampling Crushers, will give accurate, usable samples without the use of auxiliary apparatus.

Fan Engineering

"Fan Engineering," edited by Richard D. Madison, Buffalo Forge Co., 148 Mortimer St., Buffalo, New York, 808 pages, $6.00.

This handbook, long considered the "Bible" of the air handling industry, is now offered in its fifth edition. Expanded coverage of air-conditioning equipment is given and charts and tables have been revised to take into account changes effected since 1938, the date

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of the last previous issue. Formulas, discussion, and graphs give to the designer or user of fan applications the latest in air-engineering applications. The manual is in effect four volumes in one, each covering as major titles "Physics of Air," "Fans," "Fan Applications," and "Fans and Air-Conditioning Equipment."

A 19-page index renders this extensive collection of facts on fans and air circulation available to the technician who may be working in this field.

Triplex Pumps

New Data Sheet No. 66 completely pictures and describes the Aldrich Inverted Vertical Triplex Pump for petroleum, central hydraulic and high pressure applications. It contains standard ratings, approximate dimensions and diagrams of comparative discharge flows—describes the construction and operation of the pump—points out its low maintenance features. An isometric drawing and various charts are used to illustrate outstanding design features.

Copies of Data Sheet No. 66 can be obtained, free of charge, by writing to The Aldrich Pump Co., Allentown, Pa.

Heli-Coil Inserts

A twelve-page booklet containing the latest design data, tables, applications, and illustrations of Heli-Coil Screw Thread Inserts has just been published by the manufacturer, Heli-Coil Corp. (formerly Aircraft Screw Products Co.) 47-23 35th St., Long Island City 1, N. Y. A copy will be sent to interested parties on request.

Oil Burning Equipment

Peabody Engineering Corp., 580 Fifth Ave., New York, N.Y. now has available two new bulletins on oil burning equipment. Bulletin No. 111 describes Peabody Type "A" and Type "H" Oil Burners with the wide-range mechanical atomizing feature and the second, Bulletin No. 205, describes the Peabody Combination Gas and Oil Burners. Both bulletins carry cross-section blueprint drawings of both types of burners and Types "A" and "AB" wide-range mechanical atomizers. Copies are available on request.

Ship Anchors

Baldt Anchor, Chain & Forge Div., of the Boston Metals Co., Chester, Pa., have available descriptive literature on the original stockless anchor, designed to fit in hawse pipes, providing perfect stowage, replacing the old style (or pick type) anchor.

Chain Links

Baldt Anchor, Chain & Forge Div. of the Boston Metals Co., Chester, Pa.—Literature describing their Chain Links—the patented connecting link of anchor chain, eliminating the old and cumbersome chain shackles.

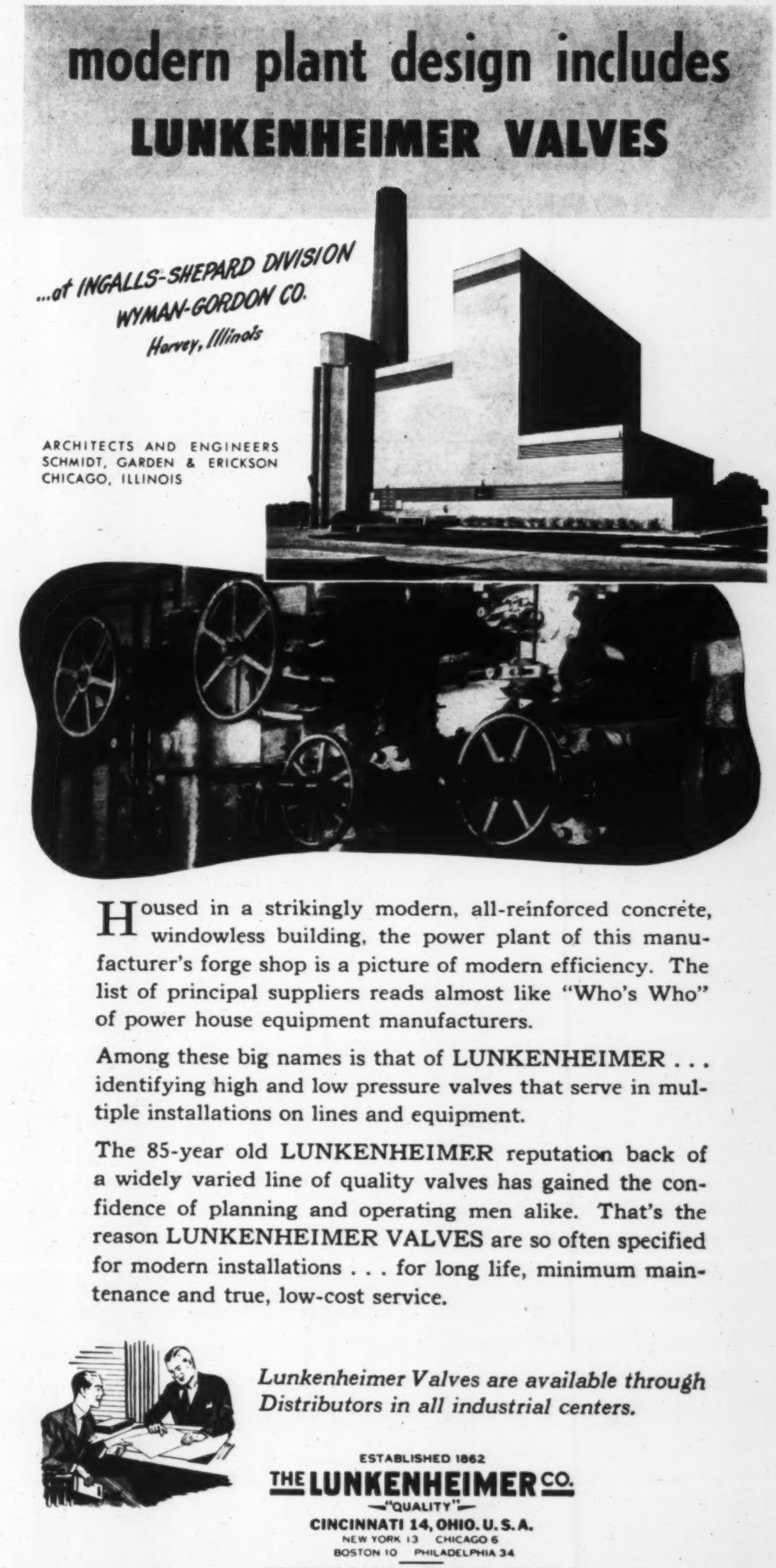
Low-Level Eductor Condensers

A new eight-page bulletin, 5-B, completely pictures and describes Schutte & Koerting Co. Low-Level Eductor Condensers which operate on the jet principle and eliminate the need for costly equipment. The only power consuming auxiliary necessary for operation is a centrifugal pump for delivering injection water.

Function drawings and photos are used throughout the bulletin to show the applications and operating characteristics of the equipment.

A variety of colors and tones illustrate flow and differentiate between exhaust steam, injection water and condenser discharges. An easy-to-read table gives maximum water consumption, steam capacities, connection sizes, dimensions and weights for the numerous sizes available.

Continued on Page 60



modern plant design includes
LUNKENHEIMER VALVES

...at INGALLS-SHEPARD DIVISION
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CHICAGO, ILLINOIS

Housed in a strikingly modern, all-reinforced concrete, windowless building, the power plant of this manufacturer's forge shop is a picture of modern efficiency. The list of principal suppliers reads almost like "Who's Who" of power house equipment manufacturers.

Among these big names is that of LUNKENHEIMER . . . identifying high and low pressure valves that serve in multiple installations on lines and equipment.

The 85-year old LUNKENHEIMER reputation back of a widely varied line of quality valves has gained the confidence of planning and operating men alike. That's the reason LUNKENHEIMER VALVES are so often specified for modern installations . . . for long life, minimum maintenance and true, low-cost service.

Lunkenheimer Valves are available through Distributors in all industrial centers.

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THE LUNKENHEIMER CO.
"QUALITY"
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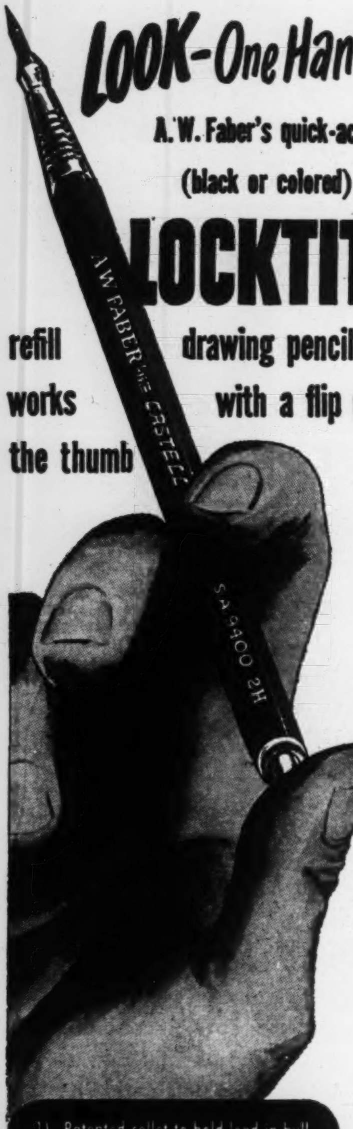
More Power to Industry Through LUNKENHEIMER VALVES



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A.W. Faber's quick-action (black or colored)

LOCKTITE

refill works the thumb drawing pencil with a flip of

1). Patented collet to hold lead in bulldog grip.
2). One-hand clutch operation to avoid touching lead and smearing fingers.

These are but two exclusive features which make LOCKTITE the favorite of professional men. Collet prevents lead breaking or slipping. Try this clean, balanced, sturdy mechanical beauty and you will surely want to own it.

Holds all standard graded drawing or retouching leads. Winner Techno-TONE No. 1930 assures best results.

ALSO AVAILABLE IN RED, BLUE, GREEN, YELLOW, CARMINE, ORANGE and WHITE —holding hardy WINNER Techno-TONE crayon leads for coloring, sketching and checking.

BLACK in degrees 4B to 9H.

Sold at Stationers', art and drawing supply stores, photo supply shops and Blueprinters.

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PENCIL COMPANY INC., NEWARK 4, N.J.

• Keep Informed

Copies can be obtained by writing for Bulletin 5-B to Schutte & Koerting Co., 1166 Thompson Street, Philadelphia 22, Pa.

AE Type R Taylor Stoker

Catalog R-A illustrates and describes the improved multiple retort underfeed either automatic, continuous ash, or power dump discharge with air cooled or water cooled grates, new "No-Blo" tuyeres, simplified drive. Capacities 20,000 to 500,000 lbs. per hour. Burns wide variety coals wet or dry. Negligible stack discharge. Reliable low cost operation and maintenance. For a copy of this catalog write to American Engineering Co., Aramingo Ave. and Cumberland St., Philadelphia 25, Pa.

Pneumatic Transmitters

Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill., announce their new Data Book No. 1001 covering Pneumatic Transmitters. This Bulletin contains complete up-to-date information on Republic Pneumatic Transmitters and their application to the measurement of flow, liquid level, pressure and density.

Alarm Flow Indicators

Henszey Co., Watertown, Wis., has available four-page Bulletin Fl-2 which describes with illustrations and drawings the simple design and rugged construction. Contains complete information and details of new automatic electric alarm system which eliminates need for constantly checking readings. Bulletin of interest to those who require an accurate instrument to indicate rate of flow of any free-flowing liquid, such as boiler feed water, condensate, gasoline, light oils, milk, and other fluids.

Lovejoy Variable Speed Transmissions

Lovejoy Flexible Coupling Co., 5032 W. Lake St., Chicago 44, Ill., illustrated 36-page catalog and handbook describes and pictures Lovejoy Variable Speed Transmissions, and "Select-O-Speed." Design, construction, ratings, dimensions, operational and engineering data, applications, and photographs of typical installations. Types of control and formulas for determining exact speeds, pitch diameter of sheaves and belt length.

Anaconda Free Cutting Brass Rods

The American Brass Co., Waterbury 88, Conn., has available Publication B-14—24 pages of basic information on seven free cutting copper alloys.

Centrifugal and Reciprocating Pumps

Warren Steam Pump Co., 22 Bridges Ave., Warren, Mass., announces bulletins available covering centrifugal pumps, single and multistage, pressure range to 1200 p.s.i., capacities to 50,000 GPM, horizontal and vertical types, open or enclosed impellers. Also, bulletins covering reciprocating pumps, horizontal and vertical single and duplex piston, single and duplex plunger, single, duplex and compound hydraulic, steam heat vacuum, automatic pump and receiver, etc.

Air-Cooled Engines

Wisconsin Motor Corp. announces a new 54-page Catalog in which are illustrated, in detail, numerous factory operations, showing how Wisconsin Air-Cooled Engines are made. Also illustrated and described are numerous service applications. These consist of action pictures and are grouped by application which cover the principal fields in which Wisconsin Air-Cooled Engines are extensively used. Also included are a list of United States, Canadian and Mexican distributors. A copy of this catalog may be secured by addressing a request to Wisconsin Motor Corp., Milwaukee 14, Wisconsin.

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THEORY &
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Meet
D. A. STUART OIL COMPANY

SELDOM does the most carefully developed scientific theory provide the final answer in the shop; neither is practical experience entirely dependable. It usually takes a combination of both in order to select and apply the cutting fluid that will give the best results on a given machining job.

D. A. Stuart Oil Company offers you a combination of theory and practical experience that pays dividends in better machining and fewer production headaches. The *theory* emanates from research in the modern D. A. Stuart laboratories; *practical* approach comes from men who have years of experience in shop problems and techniques. That is why Stuart products so often smooth out jobs on which other cutting fluids fail. Ask your D. A. Stuart Oil Co. representative to tackle your tough jobs.

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". . . D. A. Stuart's SOLVOL Water Mixed Cutting Compound was put in on a trial basis for milling high carbon alloy steel. High speed alloy cutters were used and it was found that SOLVOL increased the cutter life 3 to 4 times over what they had been getting. . . ." Write, if you would like to have a booklet on SOLVOL.

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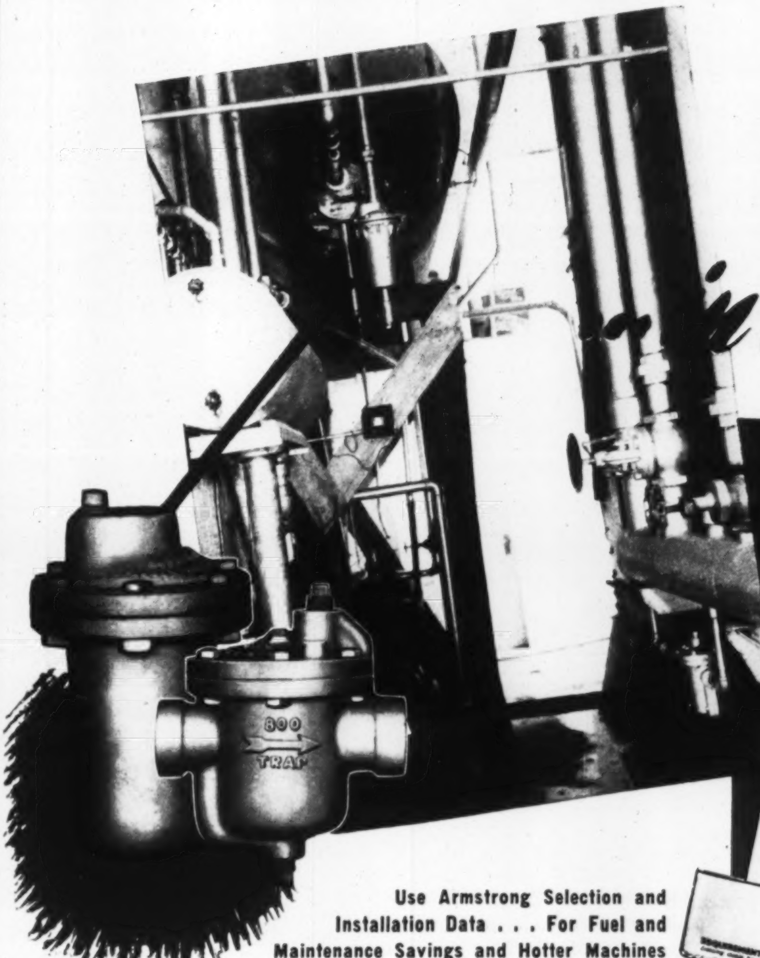
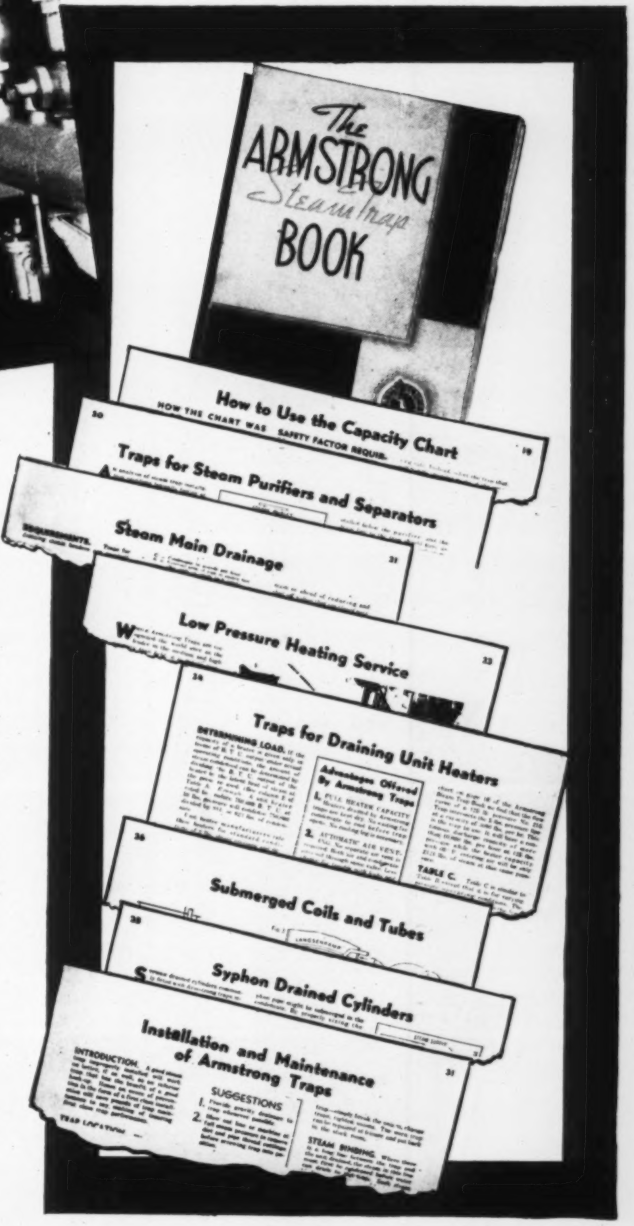


How to get the right steam trap *in the right place!*



The ARMSTRONG Steam Trap BOOK

How to Use the Capacity Chart

Traps for Steam Purifiers and Separators

Steam Main Drainage

Low Pressure Heating Service

Traps for Draining Unit Heaters

Submerged Coils and Tubes

Syphon Drained Cylinders

Installation and Maintenance of Armstrong Traps

Use Armstrong Selection and Installation Data . . . For Fuel and Maintenance Savings and Hotter Machines

There is more to good steam trapping than meets the eye. For example, intelligent trap selection involves not only the normal condensate load but must take into account peak load and the amount of air to be handled as well. The Armstrong Steam Trap Book tells how to figure condensate loads, what to do about large amounts of air and how to determine trap capacity needed for various services. It follows up with actual hot-condensate capacities of Armstrong traps. (Some trap capacity figures are based on cold water ratings, misleading because any trap will handle more cold water than it will hot condensate).

Then, because a properly selected trap won't function efficiently if it is not correctly installed, The Armstrong Steam Trap Book provides complete data on installation practice. But, even the Steam Trap Book can't think of *everything,* so the Armstrong factory and trained sales representatives stand ready to give you a lift on the really tough trapping problems.

These are a few of the reasons why Armstrong traps can be sold on a basis of "COMPLETE SATISFACTION OR YOUR MONEY BACK."

Send for a copy of the Steam Trap Book and plan now to modernize your condensate drainage system with Armstrong traps.

ARMSTRONG MACHINE WORKS
894 Maple St., Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

NEW TIMKEN® "DOUBLE-ZERO" BEARING

...raises the standards of accuracy in high precision applications!

UNTIL now, the most accurate Timken® bearing on the market has been the "Zero" bearing, with a maximum run-out of 150 millionths of an inch. This precision Timken bearing has made possible high standards of accuracy throughout industry.

Now The Timken Roller Bearing Company has developed the "Double-Zero" bearing which is *twice as accurate* as the "Zero"! Maximum run-out is only 75 millionths of an inch, and the average run-out is well under this.

It offers an opportunity for new and greater precision in machine tool spindles, scientific instruments, and many other applications where extreme accuracy is essential.

As an extra step in manufacture, after assembly, a natural and true geometric contact is generated between all rotating parts of the "Double-Zero" bearing. This results in a "Generated Unit Assembly". It assures positive roll alignment, long lasting precision, permanent adjustment and smoother operation.

The "Double-Zero" bearing is the latest example of Timken leadership in serving the bearing needs of all industry . . . one more reason why it pays to look for the trade-mark "Timken" on every tapered roller bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This label on a product means its bearings are the best.

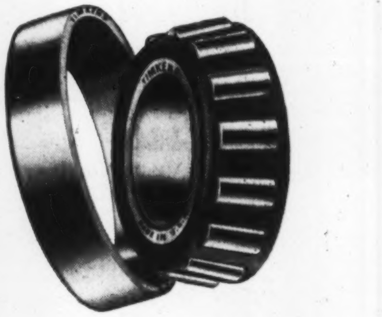
A PRECISION TIMKEN BEARING FOR EVERY REQUIREMENT

CLASS	**"00" (DOUBLE-ZERO)**	**"0" (ZERO)**	**"3" (THREE)**
RUN-OUT	.000075″	.000150″	.000300″
TYPES AVAILABLE	Standard Single Row	Standard Single Row	All types
SIZE RANGE	Up to 10″ O.D.	Up to 12″ O.D.	Up to 12″ O.D.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST →◎← LOADS OR ANY COMBINATION ✳